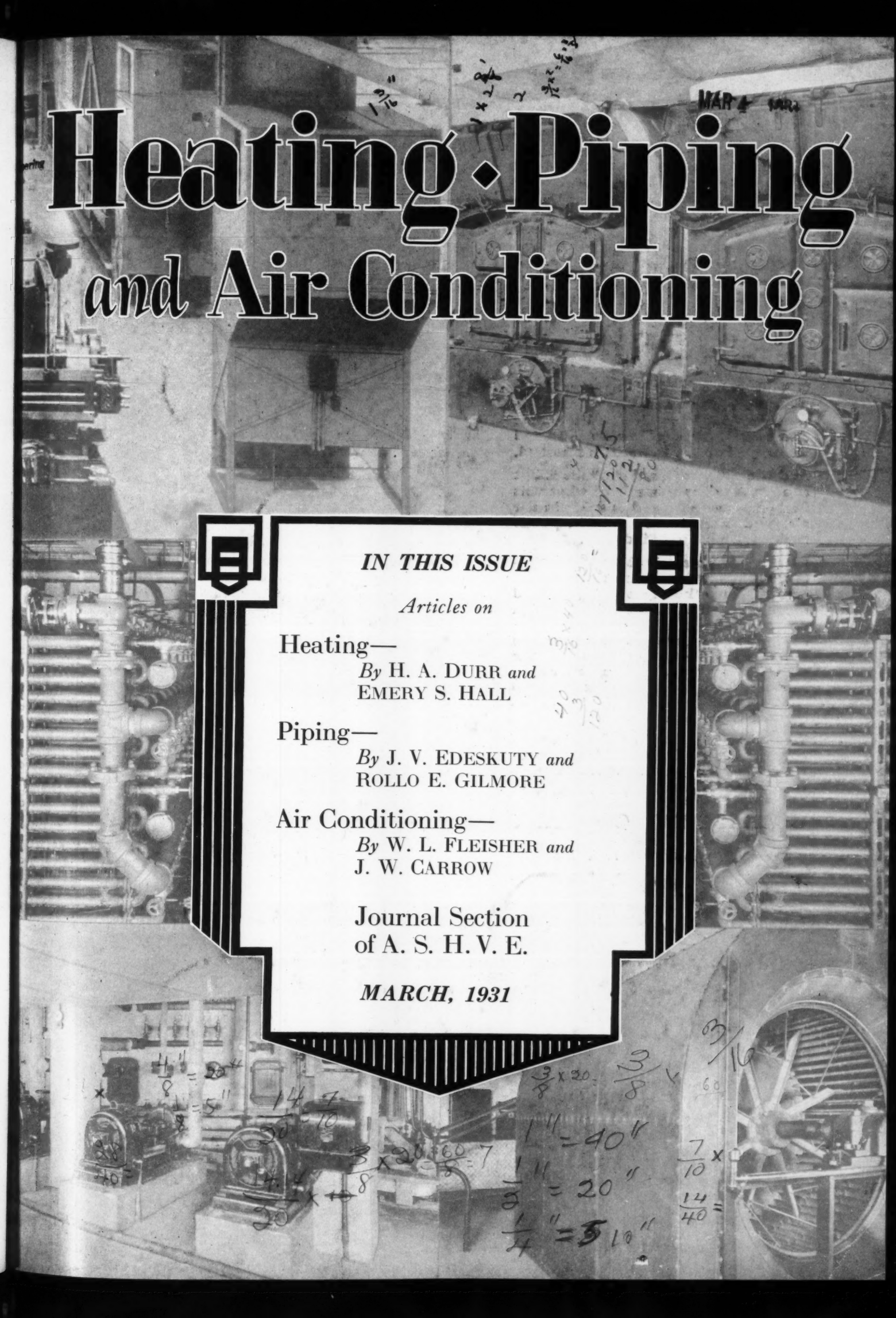


Heating · Piping and Air Conditioning

IN THIS ISSUE

Articles on

Heating—
By H. A. DURR *and*
EMERY S. HALL

Piping—
By J. V. EDESKUTY *and*
ROLLO E. GILMORE

Air Conditioning—
By W. L. FLEISHER *and*
J. W. CARROW

Journal Section
of A. S. H. V. E.

MARCH, 1931

Heating · Piping
and Air Conditioning

CLARAGE Fans and Air Washers in the Chicago Board of Trade

THIS great office building—one of the finest in the world—is entirely Clarage equipped for air conditioning. There are 21 Clarage Type HV Fans and 5 Clarage Type V Air Washers installed.

And the Chicago Board of Trade is but one outstanding example of what this Company has done and is doing in the air conditioning field, both in public building work and in industry.

Clarage equipment is thoroughly modern, incorporating many features not common to other types. The sealed dust-proof, oil-tight bearings and high efficiency, power saving feature on the fans, and the improved (low pressure) nozzles and one-man eliminators on the air washers are decided improvements. Further, Clarage engineering is sound and conservative. You can depend upon our recommendations.

We make a complete line of equipment, covering all ventilation and air conditioning requirements. Write for Clarage Catalogs.

CLARAGE FAN COMPANY
KALAMAZOO, MICHIGAN
Sales Engineering Offices in Principal Cities

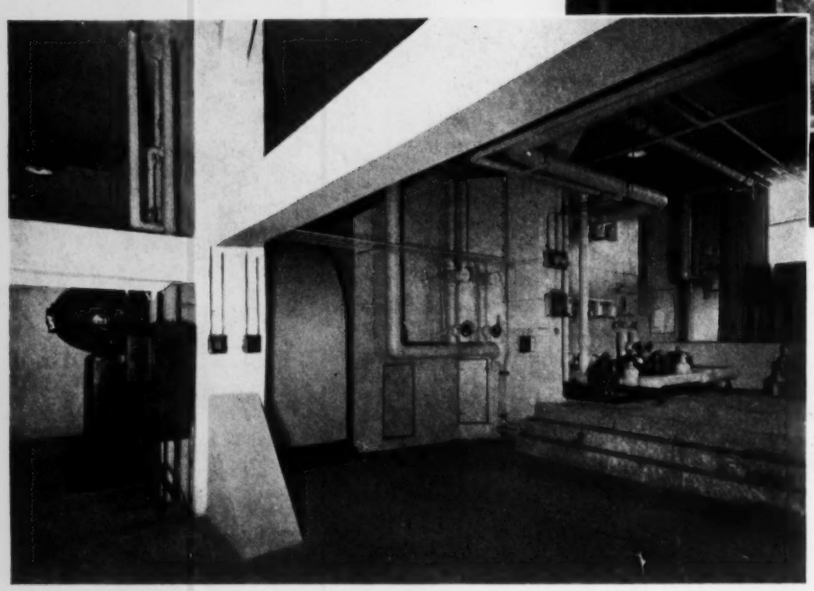


PHOTO at left shows air conditioning unit, S-5 in Board of Trade Building (Clarage Type HV Fan and Type V Washer).

Architects: Holabird & Root.

Engineer: J. A. Sutherland.

Heating and Ventilating Contractors: Wendt & Crone Co.

Heating · Piping and Air Conditioning

FROM ARTICLES IN THIS ISSUE

"All of these conditions are inter-related. Design, color, proportion, light and air all may affect the character of the heating, and it is difficult for an architect to consider one without considering the other."—*Emery Stanford Hall.*

"Savings have exceeded expectations. These savings are due to better efficiency, the total coal consumption for the increased output of 225 tons per day being 20 tons less than the consumption for an output of 160 tons with the old plant, and to the production of the required electric energy as a by-product. The total coal consumption per ton of paper has been reduced from over 2000 lb. to 900 lb."—*J. V. Edeskuty.*

"There are probably more unusual conditions to meet in a match factory than in almost any other one air conditioning problem because two sets of conditions arise, having no relationship to each other, but each acting on the other to upset the other."—*Walter L. Fleisher.*

"It is interesting to note the method of feeding radiators in the buildings which are at a higher level than the overhead main. . . . The radiator thus serves as an enlargement to the main hot water line and a portion of the water circulates through it."—*H. A. Durr.*

"For distilling water with steam heat a minimum of ten pounds pressure is desirable, although some will operate with as low as five pounds pressure, but at reduced capacity. Others are recommended for heating with 35 to 70 pounds steam pressure. Theoretically, approximately nine pounds of steam per gallon of distilled water is required, although in actual practice the figure is conservatively 9½ pounds."—*Rollo E. Gilmore.*

"To prevent heat from being carried into the fresh air supply, a canopy of wood frame construction was erected and covered with ½-in. corrugated asbestos roofing, above the intakes with an overhang of ten feet. Six feet in front of the intakes, on all sides, is a baffle six feet high of the same material. A spray of cold water was added to the roofs through a ¾-in. pipe."—*J. W. Carrow.*

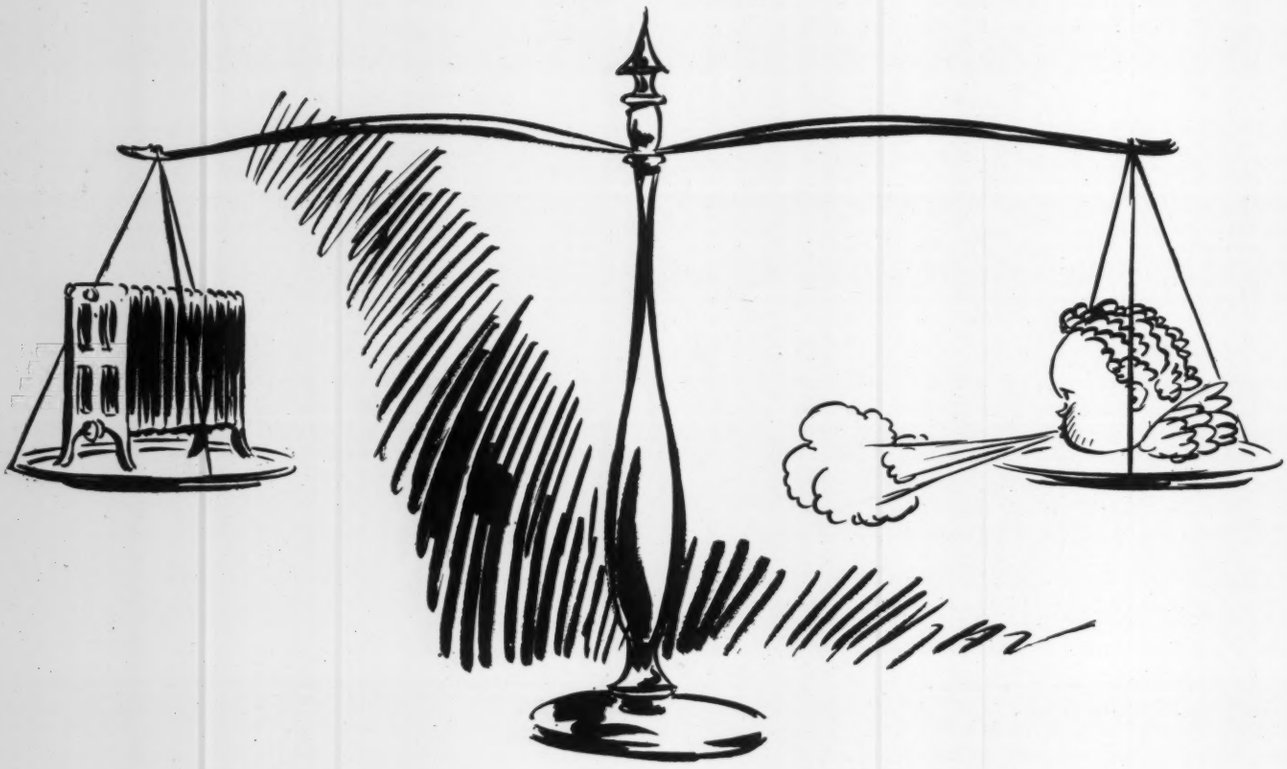
"From these examples, it is clear that water in the steam is a contributing cause to the deterioration of the pipes and fittings, especially when steam travels through the line at high velocity."—*W. H. Wilson.*

"Coal consumption was checked for the three years preceding the (weather-stripping) installation just described, and for the three years just after the work was done. The figures show that . . . . ."—*Some Reports on Research.*

"I am returning herewith your card in regard to subscription renewal and want to tell you that I am only too pleased to take advantage of the offer.

"Your magazine is by far the outstanding journal in the air conditioning field and I know that the splendid character of the journal will be maintained."

"I should like to take this opportunity to congratulate you upon the splendid magazine which you are issuing. When I subscribed as a Founder, I did so with the sole thought of being of what little assistance I could in instituting a representative magazine for this Industry; I must say that the result has been far beyond my expectations."



BALANCE

Satisfactory heating is a problem of balance. The supply should balance the demand, and this balance should be maintained throughout any variations of outside weather.

The need for exact balance is not alone in the interests of comfort and health, though this is increasingly important. When the supply exceeds the demand by so little as to raise building temperature one degree, fuel consumption increases approximately 3 per cent, and cost likewise.

Temperature, sun and wind create wide and sometimes extremely sudden fluctuations on the demand for heat. The Dunham Differential Vacuum Heating System provides a controlled supply that is equally variable.

Hot steam, cool steam or warm steam under accurate control balance changing demand due to weather variations.

DUNHAM DIFFERENTIAL HEATING

THE HEATING SYSTEM THAT "CHANGES GEARS WITH THE WEATHER"
"Cool" Steam (133° F.)
"Warm" Steam (133° to 212° F.)
"Hot" Steam (above 212° F.)

Existing vacuum return line systems can easily be changed over to Differential operation at a cost which will be paid out of the fuel savings.

C. A. DUNHAM CO.

450 East Ohio Street
Chicago, Ill.

1731

TABLE OF CONTENTS

MARCH, 1931

Page

PIPING AN INDUSTRIAL HIGH PRESSURE PLANT—ELECTRIC POWER AND PROCESS STEAM LOADS BALANCED 189
By J. V. Edeskuty

AIR CONDITIONING IN INDUSTRIAL PROCESSES 196
By Walter L. Fleisher

THE ARCHITECT'S DESIGN AND HEAT ECONOMY 203
By Emery Stanford Hall

SELECTING STERILIZERS 210
By Rollo E. Gilmore

COMBINATION STEAM AND HOT WATER SYSTEMS HEAT COURT HOUSE AND JAIL 214
By H. A. Durr

HEATING AND AIR CONDITIONING THE CLEVELAND UNION TERMINAL 219
By J. W. Carrow

SOME REPORTS ON RESEARCH 224

"OPEN FOR DISCUSSION" 226

EDITORIALS 271

PRACTICAL PIPING PROBLEMS 272
By W. H. Wilson

ADVERTISERS' INDEX (Advertising Section) 162

JOURNAL SECTION OF A. S. H. V. E.

Wind Velocity Gradients Near a Surface and Their Effect on Film Conductance, by F. C. Houghten and Paul McDermott 229

Proceedings of the 37th Annual Meeting 238

Bulletin Section 264

BOARD OF CONSULTING AND CONTRIBUTING EDITORS

Heating
Samuel R. Lewis
Alfred J. Offner
E. B. Langenberg
James C. Peebles
John D. Small
Homer R. Linn
Lee P. Hynes
Frederick D. Mensing
R. P. Schoenijahn
A. K. Ohmes
Samuel E. Dibble
J. C. Hornung
John D. Preble
A. Beaurrienne
T. S. Tenney
J. D. Hoffman

Piping
A. W. Moulder
Sabin Crocker
Lewis Lipman
E. O. Eastwood
A. R. Acheson
George B. Mulloy
J. J. Harman
C. W. Kimball
David J. Jones
Percy R. Owens
E. L. Ellingwood
R. C. Doremus

Air Conditioning
Dwight D. Kimball
Walter L. Fleisher
John Howatt
Frank B. Rowley
Alfred Kellogg
John F. Hale
E. P. Heckel
H. C. Murphy
Philip Drinker
R. S. Hawley
Charles S. Leopold
William A. Hanley

R. V. SAWHILL, *Editorial Director*
CHAS. E. PRICE, *Research Editor*
L. B. SPAFFORD, *Engineering Editor*
C. M. BURNAM Jr., *Associate Editor*

Published Monthly by **Engineering Publications, Inc.** 1900 Prairie Avenue, Chicago

TERMS OF SUBSCRIPTION
Anywhere in the world, $3.00 per year.
Current copies, 50c each. Back numbers, $1.00 each.

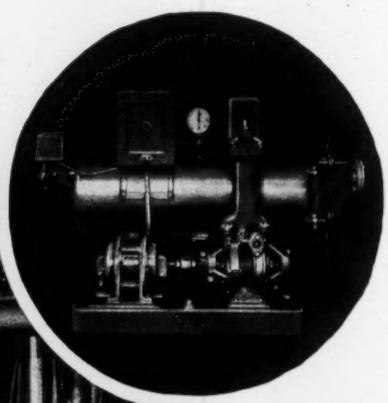
Copyright 1931, by Engineering Publications, Inc.

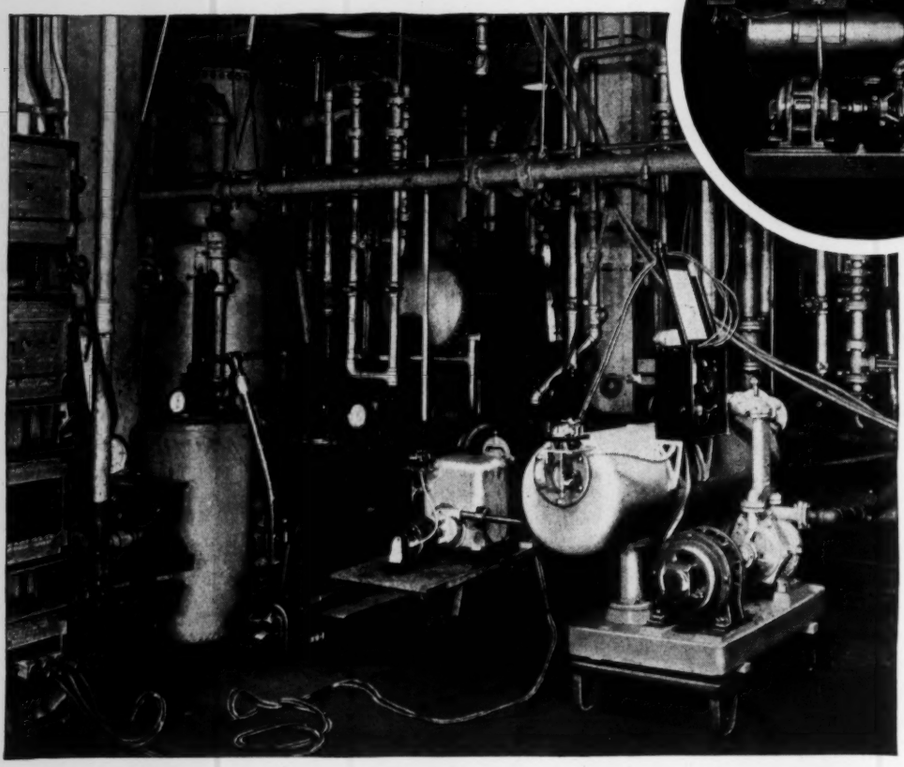
F. P. Keeney, *President and Treasurer*
E. DeForest Winslow, *Vice President*
O. T. Carson, *Secretary*

Address all Correspondence to Chicago Office
New York Office, Room 1706-1707, 110 East 42nd Street
Pittsburgh Office, Room 604, Chamber of Commerce Bldg
Detroit Office, Room 410, Donovan Bldg.
Philadelphia Office, Room 1507, Finance Bldg.

MEMBER AUDIT BUREAU OF CIRCULATIONS

This Test Laboratory is your guarantee





Jennings Vacuum Heating Pumps are furnished in capacities of 4 to 400 g. p. m. of water and 3 to 171 cu. ft. per min. of air. For serving up to 300,000 sq. ft. equivalent direct radiation. Write for Bulletin 85.

Laboratory in the Nash factory where Jennings Pumps are tested.

THERE is just one way to make certain that a vacuum heating pump will serve satisfactorily on the system for which it is intended. This is to know, beforehand, the actual measured air and water capacities of the pump.

All guess-work about this important factor is eliminated when you specify a Jennings Vacuum Heating Pump. Jennings published ratings are substantiated in a well-equipped laboratory in which every Jennings Pump is carefully checked before shipment. Air and water capacities are determined by actual tests under working conditions of vacuum and pressure. Each pump is tested as a unit, with its own motor and its own control equipment. This test laboratory is your guarantee of good heating pump performance.

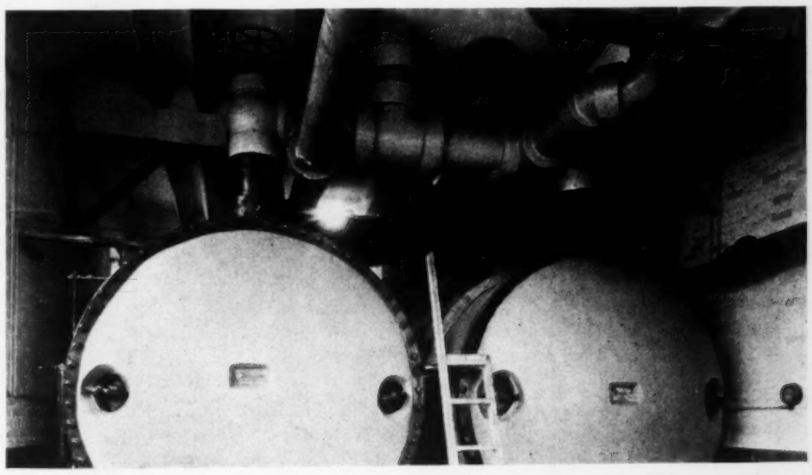
Jennings Pumps

THE NASH ENGINEERING CO 71 WILSON ROAD, SOUTH NORWALK, CONN.

Heating · Piping and Air Conditioning

Vol. III March, 1931 No. 3

By J. V. Edeskuty*



TWO HORIZONTAL SECTIONAL BENT-TUBE EVAPORATORS IN THE POWER PLANT OF THE WALDORF PAPER PRODUCTS CO.

Piping an Industrial High Pressure Plant—Electric Power and Process Steam Loads Balanced

THE high pressure plant for the Waldorf Paper Products Co. of St. Paul, Minn., was designed by Ralph D. Thomas and associates, consulting engineers of Minneapolis, and was put into operation in February and completed in October, 1929.

The installation has received considerable publicity in power magazines and a brief outline only of the general features will be given here, the main purpose of this article being the description of the problems which had to be solved in the design and installation of the piping, together with a more detailed description of the accumulator (which will appear in the April issue) and some of the heat saving equipment than has heretofore been published.

The Waldorf Paper Products Co. operated in 1927 two completely electrified paper machines, which produce chiefly boxboard, insulating board and raw material for food products containers. The steam for the dryers was partly exhausted at 23 pounds gage pressure from three reciprocating engines, driving d-c. generators of a total capacity of 1,200 kilowatts and partly supplied from the boilers through reducing valves. All electric energy required by the mill, which could not be generated with the above mentioned equipment, was purchased from the local power company.

The boiler plant consisted of six 175 lb. gage water tube boilers with a total capacity of 2,648 boiler horsepower set in batteries of two. Four of these boilers were fired with "V" type furnaces and the remaining two, of comparatively recent installation, with multiple retort underfeed stokers.

Decided to Remodel Plant

It was contemplated to speed up the two paper machines to increase the daily production from 160 tons to 225 tons and later to add a third machine. As the plant then in use was of poor efficiency and could not, due to lack of space, be sufficiently enlarged to provide

* Engineer, Ralph D. Thomas and Associates, Minneapolis.

the necessary steam, a careful investigation was conducted by the engineers to arrive at the proper procedure for remodeling the plant. Consideration was given to various ways of producing the required electric energy, namely, by purchase as before, by bleeding and condensing turbines and as a by-product of high pressure steam through non-condensing turbines.

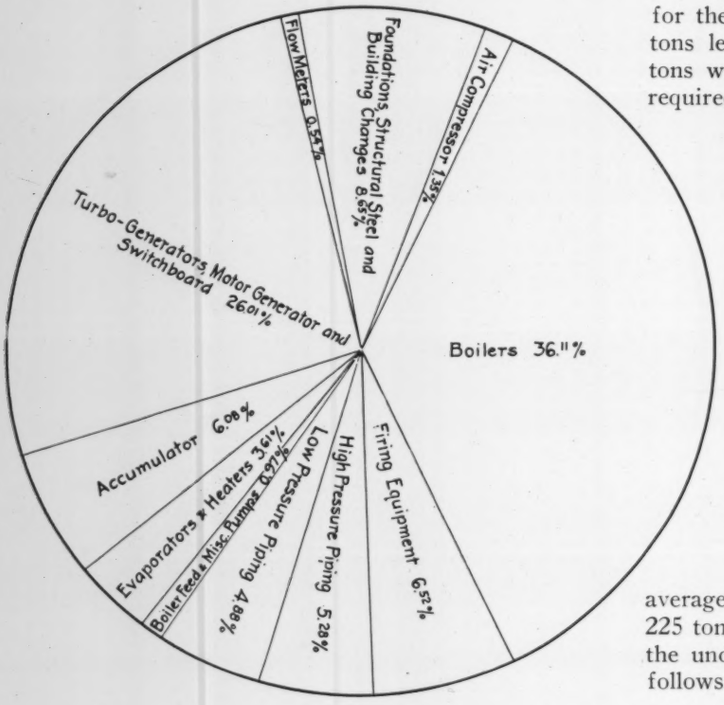

Flow Meters 0.54%
Foundations, Structural Steel and Building Changes 8.63%
Air Compressor 1.3%
Turbo-Generators, Motor Generator and Switchboard 26.01%
Boilers 36.11%
Accumulator 6.08%
Evaporators & Heaters 3.61%
Boiler Feed & Misc. Pumps 0.97%
Low Pressure Piping 4.88%
High Pressure Piping 5.28%
Firing Equipment 6.52%

Fig. 1—Diagram Showing the Division of Cost in Installing the New High Pressure Plant

To avoid exhausting steam from the turbines to the atmosphere, the process steam demand of the mill must be in excess of the steam necessary for the production of the required electric energy. The lowest pressure at which this result could be obtained would have been considerably higher than the adopted pressure of 635 pounds gage at the superheater outlet without the installation of an accumulator of large capacity. Savings to be expected with the last named method of providing the electric energy proved so large that the new plant was designed along these lines.

This plant had to be installed in the buildings housing the old 175-lb. boilers and engine-generator sets without interrupting the operation of the mill and this together with the necessary piping changes and additions taxed the ingenuity of the designers and erectors. The total cost was $750,000.00 and the division of cost is shown on the "pie" diagram, Fig. 1.

Savings Exceed Expectations

Savings have exceeded expectations. These savings are due to better efficiency, the total coal consumption for the increased output of 225 tons per day being 20 tons less than the consumption for an output of 160 tons with the old plant, and to the production of the required electric energy as a by-product. The total coal consumption per ton of paper, including that for power, has been reduced from over 2,000 lb. to 900 lb.

The arrangement of the plant is shown in the plan, Fig. 2.

A schematic arrangement is shown in Fig. 4; this may serve as a steam and water flow diagram.

The Heat Balance

Fig. 5 gives the heat balance based on the average hourly requirements for a daily production of 225 tons. An explanation of this heat balance given for the understanding of the use of the various pipe lines follows:

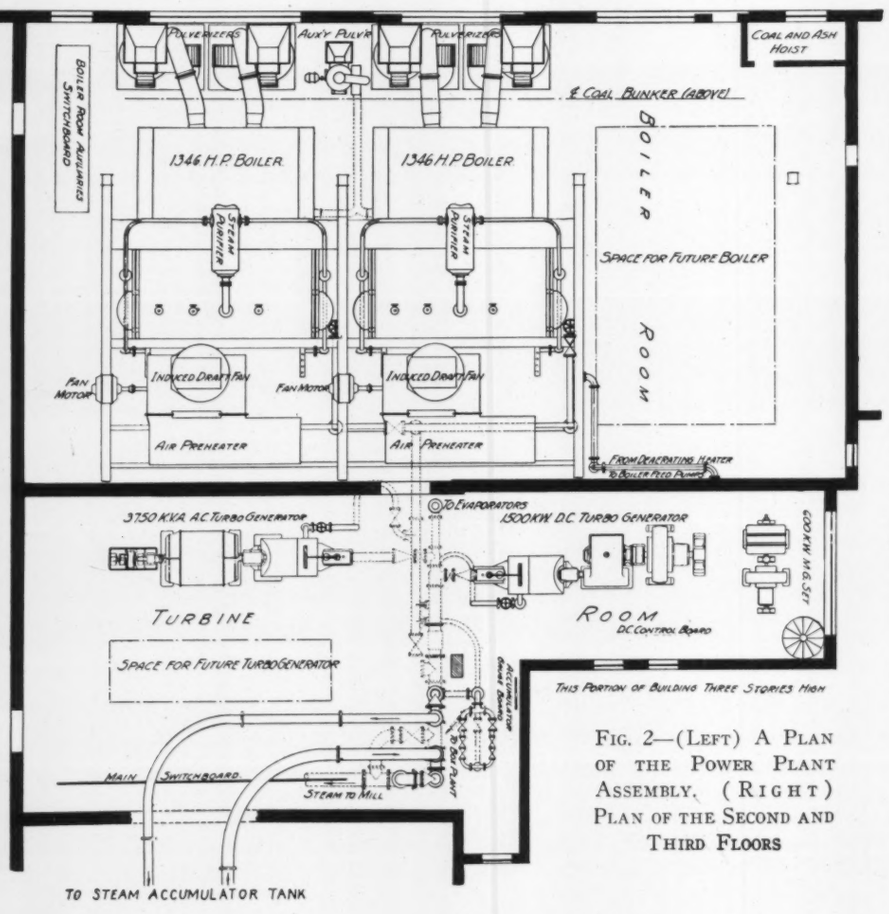


Fig. 2—(Left) A Plan of the Power Plant Assembly. (Right) Plan of the Second and Third Floors

The turbine exhaust steam is divided between the evaporators, the accumulator and the mill. The amount of high pressure steam taken from the high pressure header through reducing valves to the turbine exhaust header varies with the nature and weight of the product from the paper machines. This steam is desuperheated in the accumulator and for this purpose cold water is introduced so that the accumulator serves as a desuperheater and, to a certain extent, as an evaporator. The vapor from the evaporators—together with some steam from the accumulator—is absorbed by the open evaporator feed water heater, the deaerating heater and by the closed white water heaters. Condensate from the paper machines is pumped through the vent condensers to the deaerating heater from which the boiler feed pumps take their suction. All makeup water is evaporated and the drains from the evaporators and from the closed heater are discharged to a flash tank from which they are pumped to the deaerating heater.

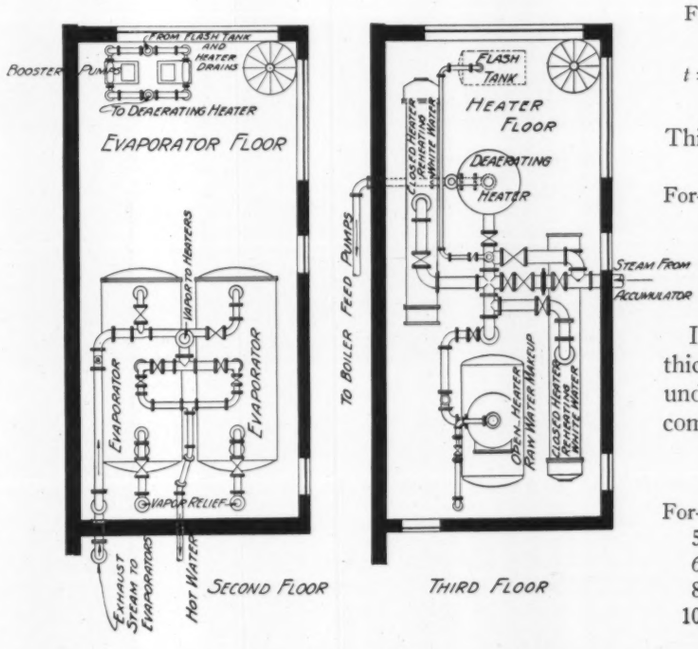
High Pressure Piping

Design. The dimensioning of the high pressure piping was based on pressure drops which were carefully calculated. The highest boiler pressure for which at that time boilers with riveted drums could be obtained at a reasonable cost was 650 lb. gage and as the electric and process steam loads could not be balanced for a throttle pressure of less than 600 lb., the piping had to be so designed as to make the maximum pressure drops through steam purifiers, superheaters, non-return valves and piping less than 35 pounds. It was assumed that the boiler drum pressure could be held within close limits to 635 lb. or 15 pounds below the maximum permissible working pressure to prevent the popping of the safety valves.

The pipe is seamless open hearth tubing calculated for 650 lb. pressure by the modified Barlow formula as used in the *A. S. M. E. Boiler Construction Code.*

For pipes ¼ in. to 5 in. nominal diameter

$$P = \frac{2S}{D}(t - 0.065) - 125$$



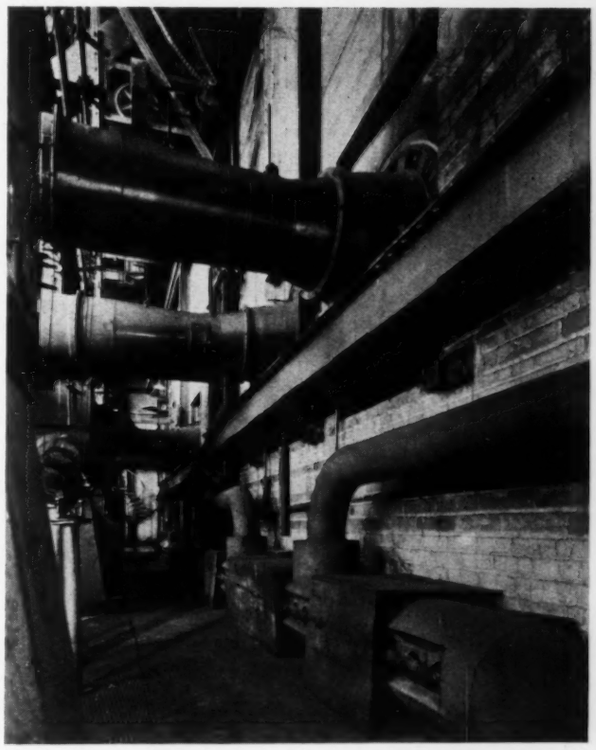


Fig 3—A View of the Boilers

For pipes of nominal diameter over 5 in.

$$P = \frac{2S}{D}(t - 0.1)$$

Where P = working pressure in lb. per sq. in.
t = thickness of wall of pipe in in.
D = actual outside diameter of pipe in in.
S = 7000 lb. per sq. in.

The required thickness for the first size mentioned is

$$t = \frac{(P + 125)\ D + 0.135}{2S}$$

For pipe over 5 in., required thickness is

$$t = \frac{PD + 0.25}{2S}$$

This would give:

For—	Outside Diameter Inches	t Inches
5-in. pipe	5.563	0.3732
6-in pipe	6.625	0.4076
8-in. pipe	8.625	0.5004
10-in. pipe	10.750	0.5991

In all sizes except for the 5-in. pipe the calculated thickness was increased by 12½ per cent to allow for under thickness mill tolerance and the nearest available commercial size was then selected, giving:

For—	Outside Diameter Inches	Thickness Inches	Inside Diameter Inches
5-in. pipe	5.563	0.375	4.813
6-in. pipe	6.625	0.46875	5.6875
8-in. pipe	8.625	0.625	7.375
10-in. pipe	10.750	0.75	9.250

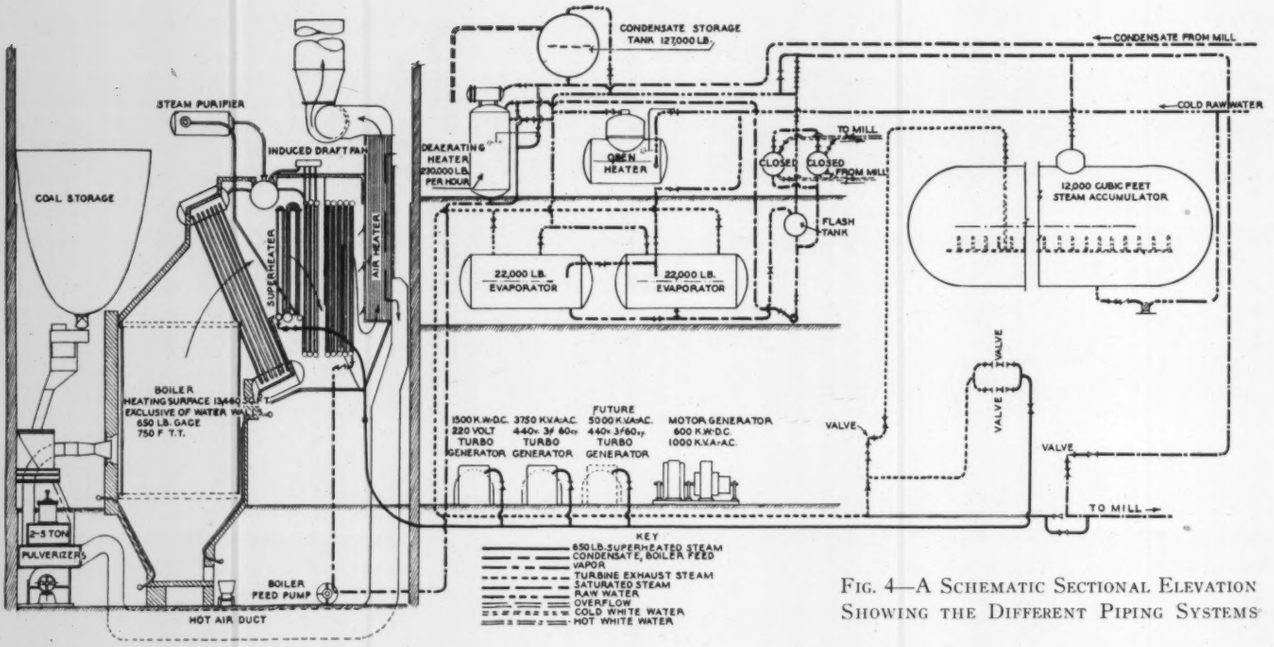


FIG. 4—A SCHEMATIC SECTIONAL ELEVATION SHOWING THE DIFFERENT PIPING SYSTEMS

Testing the Piping

The 10-in. header was built of seamless open hearth steel tubing with welded-in nozzles, reinforced with ribs. All flanges are Van Stone welded flanges of the type shown in Fig. 6. These and the fittings and valves are of 900-lb. standard construction. The ground faces of the flanges were placed in contact without gaskets and to insure a perfect, leak-proof fit, they were carefully protected in shipment.

After erection of the piping it was given a hydrostatic test under a pressure of 975 lb. per sq. in. and the flange bolts were tightened until no leak could be detected. Then the thin lips of the flanges were given a light weld, forming a seal. Great care must be exercised in this, as a heavy weld with overheating would result in warping and leaks. Before the covering was applied the high pressure piping was heated with steam from the new boilers to the maximum steam temperature and the flange bolts were again tightened.

The pressure drops were calculated for the various sizes of pipe; only those for the sizes finally selected will be given here.

The following cases were considered:

I. For the immediate future a maximum steam production of 110,000 pounds per hour from one boiler for a daily output of 225 tons of paper.

II. A maximum steam production of 180,000 pounds per hour from one boiler for a daily output of 360 tons.

III. A maximum steam production of 220,000 pounds per hour from two boilers for a daily output of 500 tons.

The pressure drops in the piping were figured from the formula given by B. N. Broido in a paper published in the *A. S. M. E. Transactions* (Vol. 56, Dec. 12, 1922, page 913).

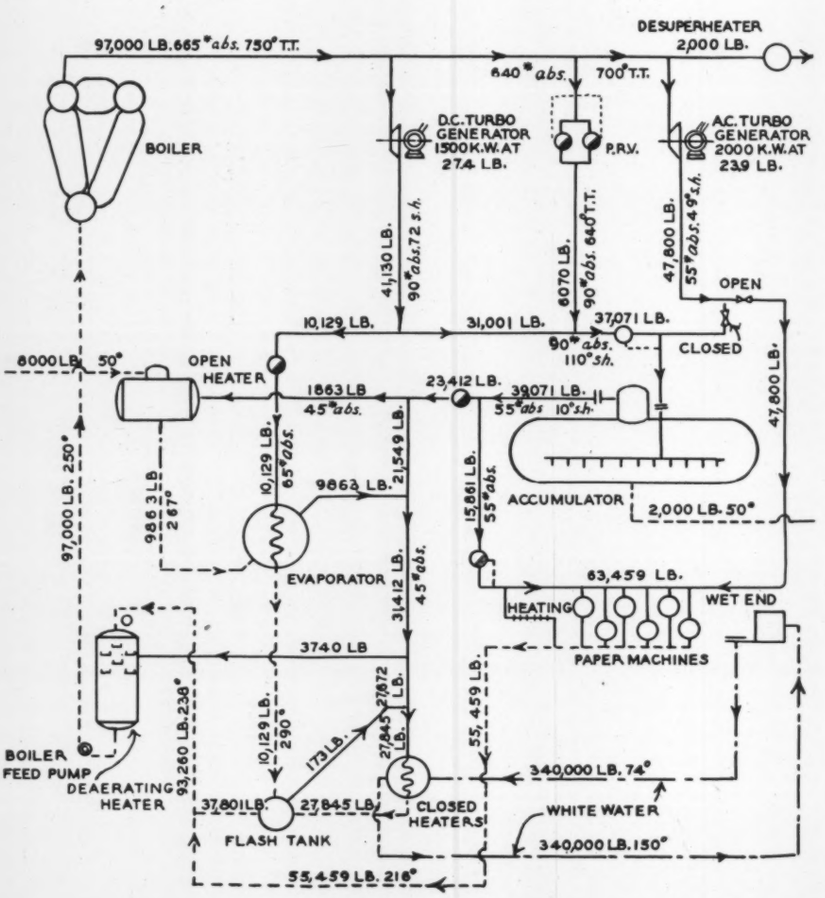


FIG. 5 — A HEAT BALANCE CHART BASED ON HOURLY AVERAGE REQUIREMENTS CORRESPONDING TO AN OUTPUT OF 225 TONS OF PAPER DAILY

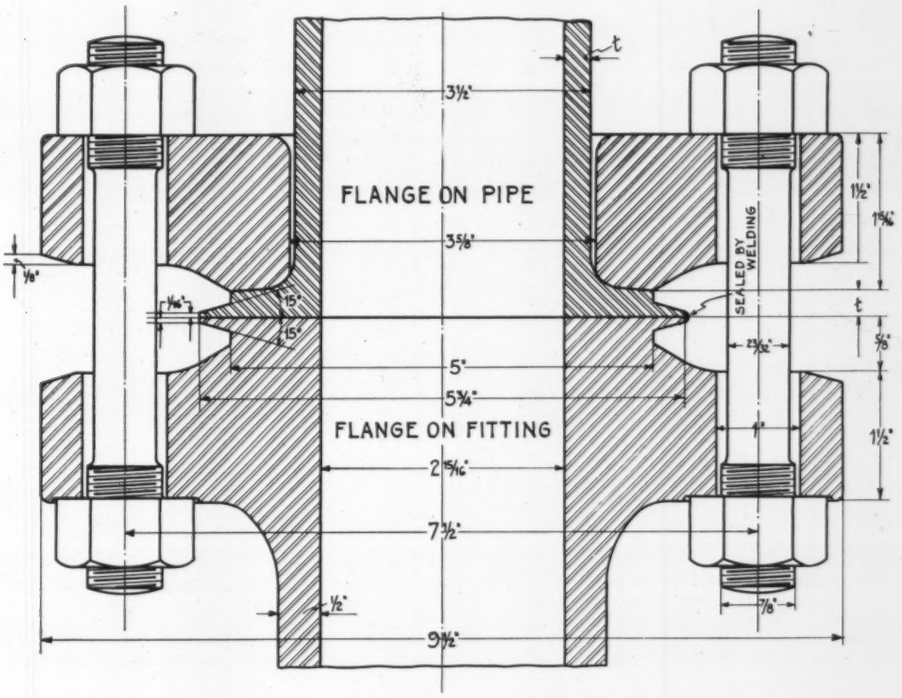


FIG. 6 — NINE-HUNDRED POUND STANDARD FLANGES FOR A THREE-INCH JOINT

$$p = \frac{CV^2L}{vd} = \text{lb. per square inch}$$

where p = pressure drop

$$C = \text{Fritche's coefficient} = 0.0000022\left(\frac{R}{144}\right)^{0.148}\left(\frac{T}{p'v}\right)^{0.148} d^{0.203}$$

V = velocity of the steam in feet per second
L = equivalent length of pipe in feet
v = specific volume of steam in cubic feet per pound
d = inside diameter of the pipe
R = 85.7 for steam
T = absolute temperature for the steam in F
p' = average pressure of the steam in the pipe in pounds per square inch absolute.

To the length of each pipe was added a length of 40 times the normal diameter for each elbow.

The pressure drops through the steam purifiers, superheaters, and non-return valves were assumed as given by the manufacturers.

I. Maximum steam flow 110,000 *pounds per hour from one boiler.* (See Fig. 7.)

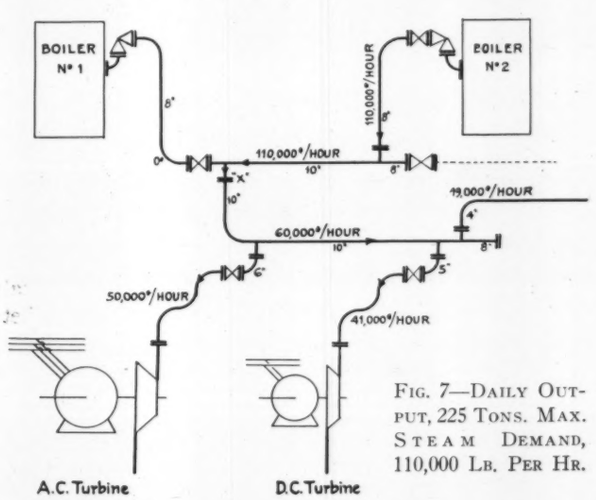


FIG. 7—DAILY OUTPUT, 225 TONS. MAX. STEAM DEMAND, 110,000 LB. PER HR.

Calculations showed that the largest pressure drop to the point marked X in Fig. 7 was to be expected from Boiler No. 2.

Maximum steam flow from one boiler, 110,000 pounds per hour. Drum pressure, 635 pounds gage. 730 deg. total temperature. Pressure drop to throttle of d-c. turbine—

Steam purifier	2.60 lb. per sq. in.
Superheater	2.50 lb. per sq. in.
Non-return valve	1.90 lb. per sq. in.

PIPE SIZE (IN.)	INSIDE DIAMETER d (IN.)	EQUIVALENT LENGTH L (FT.)	WEIGHT OF STEAM (LB. PER MIN.)	AVERAGE STEAM VOLUME FT.³/LB.	AVERAGE VELOCITY IN FT./MIN.	AREA OF PIPE CROSS SECTION	PRESSURE DROP LB./SQ. IN.
8	7.375	80	1833	1.0288	6538	0.2966	1.40
10	9.250	76.6	1833	1.0288	4040	0.4667	0.49
10	9.250	8.5	1000	1.0288	4040	0.4667	0.01
5	4.813	64	683	1.0308	5574	0.1263	1.19

Total pressure drop = 10.09 lb.
Pressure expected at the d-c. turbine nozzle = 624.91 lb. gage.

II. *Maximum steam flow from one boiler,* 180,000

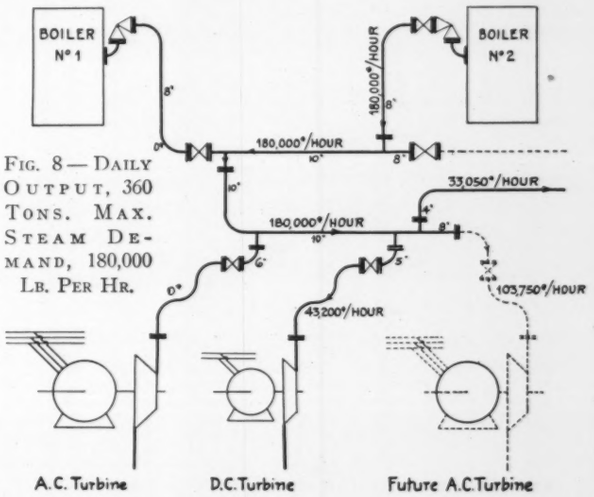


FIG. 8 — DAILY OUTPUT, 360 TONS. MAX. STEAM DEMAND, 180,000 LB. PER HR.

pounds per hour. (Steam quality as before.) (See Fig. 8.)

Pressure drop in:
Steam purifier ..... 8.2 lb. per sq. in.
Superheater ..... 6.4 lb. per sq. in.
Non-return valve ..... 5.4 lb. per sq. in.

Pipe Size (In.)	Inside Diameter d (In.)	Equivalent Length L (Ft.)	Weight of Steam (Lb. per Min.)	Average Steam Volume Ft.^{3}/Lb.	Average Velocity in Ft./Min.	Pressure Drop P Lb./Sq.In.
8	7.375	80	3000	1.0519	10,639	2.49
10	9.250	85.1	3000	1.0549	6,788	1.43
15	4.813	64	720	1.0576	6,030	1.35

Total pressure drop = 25.27 lb. per sq. in.
Pressure expected at the d-c. turbine throttle = 609.73 lb. gage.

III. *Maximum steam flow, 220,000 pounds per hour from two boilers. (Steam quality as before.)* (See Fig. 9.)

Pressure drop in:
Steam purifiers ..... 2.60 lb. per sq. in.
Superheaters ..... 2.50 lb. per sq. in.
Non-return valves ..... 1.90 lb. per sq. in.

Pipe Size (In.)	Inside Diameter d (In.)	Equivalent Length L (Ft.)	Weight of Steam (Lb. per Min.)	Average Steam Volume Ft.^{3}/Lb.	Average Velocity in Ft./Min.	Pressure Drop P Lb./Sq.In.
8	7.375	80	1833	1.0288	6358	1.40
10	9.250	76.6	3667	1.0308	8100	1.77
10	9.250	8.5	2867	1.0310	6334	0.12
5	4.815	64	720	1.0330	5889	1.32

Total pressure drop = 11.61 lb. per sq. in.
Pressure expected at the d-c. turbine throttle = 623.39 lb. gage.

The maximum steam velocities are for the 5-in. pipe, 6,030 feet per minute; for the 8-in. pipe, 10,639 feet per minute; and for the 10-in. pipe, 8,100 feet per minute.

At a water rate test conducted on the d-c. turbine the pressures were noted on calibrated gages and were found to be in close agreement with the calculated pressure drops.

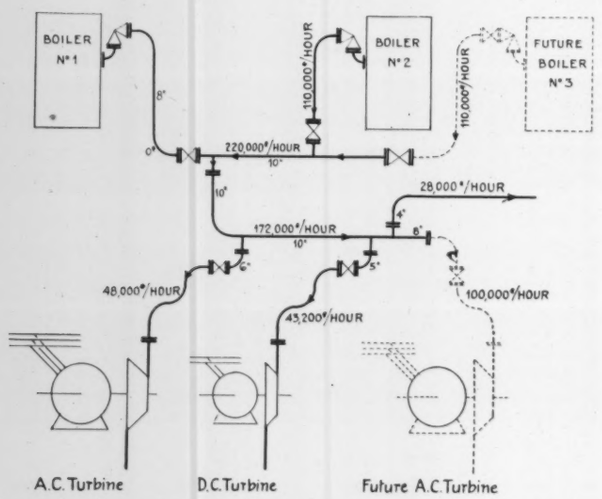


FIG. 9—DAILY OUTPUT, 500 TONS. MAX. STEAM DEMAND, 220,000 LB. PER HR.

Expansion and Suspension

The expansion of the high pressure piping was calculated for a temperature difference of 670 F between steam and the air surrounding the pipe and was taken care of by pipe bends. The bends were figured for the total temperature difference and were manufactured short by one-half the distance of the expansion so that with the heated pipe the minimum strain may be produced on any boiler nozzle, etc.

The entire piping, including the low pressure, was manufactured according to plans and specifications, without distance pieces, and there were no alterations required.

The piping is suspended on roller hangers to aid in allowing it to assume the position of minimum strain. In one instance only was the above method departed from, where a header is anchored between the 6-in. and 5-in. nozzles to which the piping to the two turbines is attached. This piping consists of very flexible compound bends, as the maximum strain exerted by it on the turbine throttle valves must not exceed 500 pounds.

The installation of the anchor was one of the most difficult problems of the job. At this point the high pressure header passed through the generator foundation of one of the corliss engines, which had to be kept in operation until the d-c. turbine could be put in service. Two steel beams were attached with studs to the generator frame and carried to a bearing on an old wall. The concrete of the generator base was then cut away to permit the erection of the header and a temporary anchor was fastened to the old foundation under the header. This anchor was later replaced, after the removal of the old corliss engine, by one fastened to the new concrete slab forming the floor of the turbine room. This piping was installed early in 1928 and to date no leaks or other troubles have developed.

Steam Purifiers

The steam purifiers are located between the boilers and the superheaters and in conjunction with the high capacity drainers serve to deliver dry steam to the superheaters, so that the steam may be discharged at the superheater outlet with the maximum temperature.

Piping Insulation

All high pressure piping was insulated with an inner layer of high temperature covering which does not disintegrate under the influence of heat and an outer layer of 85 per cent magnesium cemented and canvas jacketed.

As the high pressure piping is short, heat losses are very small.

The Boiler Feed Piping

This piping is designed for 650 pounds pressure by the Barlow formula as before and the flanges and fittings are 900-lb. standard with large male and female faced Van Stone flanges. Asbestos-filled copper gaskets are used for flanged connections.

There are two feed lines per boiler and the water level is controlled by a feed water regulator and a differential pressure regulator in each of these lines. The regulators and valves are arranged in the following order: An angle valve, the feed water regulator, the differential

pressure regulator, a check valve and another angle valve. The angle valves are used to shut off the boiler against the pump discharge header when the boiler is down and to permit repairs to the check valves and regulators.

Blow-Off Piping

The boilers and lower water wall headers are blown down into a special blow-off tank, which retains the full amount of blow-down from one boiler, so that this water may cool before being discharged to the sewer. An arrangement of baffles in this tank causes the cooled water to overflow through a syphon to the sewer. With the completed discharge of this cooled water the seal of the syphon is broken and the hot water remains in the tank until the next blow down. An 8-in. vent from the tank to the roof allows the discharge of flash steam from the water which leaves the boiler at a temperature of 486 F.

Low Pressure Piping

For ease of erection of the many different pipe lines and to make possible the receipt of proposals in the shortest possible time, the following system was resorted to:

Each individual line was assigned a base letter and every piece was required to be marked by the successful bidder with this base letter and a number. The lists gave full information as to the number of each piece required, the dimensions and other details.

Identification of Piping Systems

To familiarize the operating crew with the various pipe lines and their use, they were after installation painted with distinctive colors for identification.

The colors were:

High pressure steam lines	vermillion
Turbine exhaust and mill headers	maroon
Accumulator discharge	orange
Evaporator vapor	yellow
First effect vapor when operating evaporators in double effect	cream
Fresh cold water	light blue
Fresh hot water	dark blue
Cold white water	light green
Hot white water	dark green
Condensate	purple
Blow offs and all other lines to sewer	black

White Water Heaters

The white water, which is used for diluting the stock in the beaters, should, for best results, be heated to about 150 F. In the old plant this was accomplished in the usual way by mixing this water with low pressure steam and the steam so used was lost and had to be replaced with raw water.

As all the water used in this mill must be pumped from deep wells and contains a considerable amount of hardness and other impurities, raw feed water evaporators seemed to be the solution in view of the contemplated high pressure for the new plant. The installation of feed water evaporators could be made feasible by the use of closed heaters, which would serve the double purpose of heating the white water and of condensing the evaporator vapor and in this way return the condensed steam formerly mixed with the white water and lost to the sewer.

Attempts in the past by this mill to accomplish this with the conventional type of closed heaters had produced unsatisfactory results. The greater portion of the stock used in the heaters consists of waste paper of all kinds and the white water which is taken from the machines contains paper, glue and other substances which deposit in the heaters and make frequent cleaning necessary.

The greatest precautions were, therefore, taken in the design of the heaters. They are two-pass heaters and have floating heads and two-inch admiralty metal tubes. The covers are hung from small davits and can be removed very quickly for inspection and cleaning. Room was reserved in front of the heaters for the use of full length rods for cleaning.

The water piping was designed for operation of the heaters singly or in series. The valves are arranged so that the flow of water through the heaters can be reversed for removal of deposits which may collect where the water enters the tubes. Thermometers are installed in the lines to and from the heaters and the amount of vapor entering these heaters is controlled to obtain the desired temperature. Pressure gages are also installed at the inlet and outlet of the heaters and when these gages indicate a certain pressure drop, the heaters can be opened for cleaning.

For a considerable time these heaters were in operation without cleaning or reversal. Their tubes are now turbined at intervals of 8 weeks and the time required for cleaning one heater is 3 man-hours.

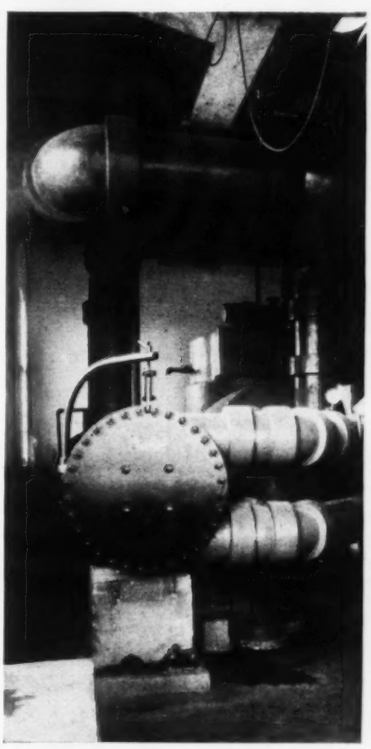


FIG. 10—WHITE WATER HEATERS

The evaporators are located on the second floor of a two-story addition built over the d-c. turbogenerator. Other equipment housed in this addition are the white water heaters, the open evaporator feed preheater, the deaerating heater, the flash tank and the booster pumps. Their relative location can be seen in Fig. 2.

The steam exhausted from the turbine and used at a pressure which will produce the required amount of boiler feed make-up is condensed in the bent tubes of the evaporators and discharged through drainers into the flash tank. The booster pumps take their suction from the flash tank and also directly from the white water heater drainers and discharge to the deaerating heater. The piping arrangement permits the use of the two evaporators singly, in parallel or as a two effect evaporator.

The operation and installation of the accumulator will be explained by Mr. Edeskuty in the April issue.

Air Conditioning in Industrial Processes

"THERE ARE PROBABLY MORE UNUSUAL CONDITIONS TO MEET IN A MATCH FACTORY THAN IN ALMOST ANY OTHER ONE AIR CONDITIONING PROBLEM,"

Says Walter L. Fleisher*

THE HISTORY of match making has always been classified as a chemical development and in a sense, this is its true place in history—for the combination of various chemicals to give the desired combustion without danger and only when desired (that is, avoiding spontaneous combustion), is certainly in the field of chemistry.

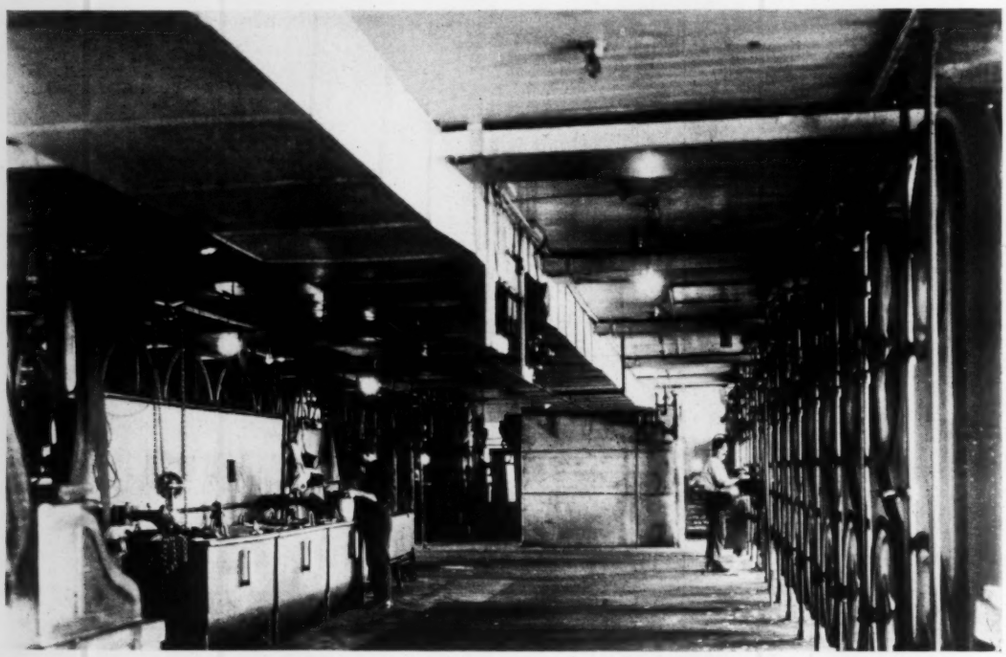
Unlike baking, which dates back to prehistoric times, the making of matches is relatively a very late development, and again unlike baking, air conditioning in the match factory is a requirement because of modern machinery and quantity production, and not actually necessitated by the organic substances entering into the manufacture of matches. Where matches may be classified under the inorganic groups, bread is distinctly under the organic group.

The First Matches

The first attempt to make matches in our modern sense may be credited to Robert Boyle, who directed a certain Godfrey Haulswitz in 1680 how to make phosphorus which, ignited by friction, lighted splints of wood, tipped with sulphur. The interest of the readers of this article in the above historical event is double, in that the same Robert Boyle is responsible for the enunciation of the principle of expansion of gases being inversely proportionate to their absolute pressures, the law known as Boyle's law, basic in thermodynamics and one of the underlying laws of air conditioning.

The Haulswitz method of match making was however, very little used, due to the expense of the phosphorus; and flint and steel were used almost exclusively up to the beginning of the 19th century. In 1805 a method of igniting a splint coated with sulphur and with a tip of chlorate of potash and sugar by dipping in a bottle of sulphuric acid was used. In 1827, a druggist by the name of John Walker prepared splints of cardboard, coated with sulphur and tipped with sulphide of antimony, chlorate of potash, and gum. With these matches was sold a folded piece of glass paper through which the splint was drawn, thus igniting the splint. In 1833 the first phosphorus matches were commercially manufactured almost simultaneously in Austria and Germany. The use of the common white and yellow phosphorus was accompanied with great distress and disease to the workers (modern methods of cleanliness and air conditioning might have overcome this evil) so the making of phosphorus matches came into ill-repute, deservedly; but it took much propaganda and inter-

* Consulting engineer, New York City.



A View of Part of a Match Factory Showing One of the Air Ducts

minable argument to prevent the use of this poisonous substance, and acts against its use were only promulgated as lately at 1910. Probably the prohibitory law would not have passed then, had not a substitute been discovered—amorphous phosphorus, which in combination with chlorate of potash, bichromate of potash, and sulphide of antimony, developed a satisfactory match.

Necessity of Air Conditioning

The safety match was introduced in about 1852, but as air conditioning as yet enters so little into its manufacture, we will confine ourselves almost entirely in this article to the "strike-anywhere" match, which still is the major production in the match industry and which, by the way, is the largest utilizer of glue of any manufacturing process, notwithstanding the common idea that furniture requires more glue than any other industry.

A Large Air Washer Being Constructed for a Match Company

As the use of matches became more general, modern machinery was developed for their manufacture. The Diamond Match Company, which for years had a virtual monopoly in the match industry in America and whose secret processes and patents kept the business in its hands for nearly a half a century, developed automatic machinery for large scale production. This machinery required continuous operation involving a number of processes most of which, including dipping, and drying, and re-dipping required the drying between dips as essential to proper manufacture. This brought about the necessity of air conditioning, and the Diamond Match Company was one of the first industrial concerns to go thoroughly into the subject and to utilize air conditioning in a large commercial way.

In order to understand the need and use of air conditioning in the match factory, it is essential to have some idea of the modern "strike-anywhere" match and the machinery that enters into its manufacture, but before going into the description of the "strike-anywhere" match and its manufacture, it might be interesting to give a brief review of some of the legislation that led up to the prohibiting of white and yellow phosphorus. The reason for this description is because, had modern air conditioning been at all appreciated at that time, it might have delayed still longer the elimination of the poisonous ingredients that entered into the manufacture of matches for so many years.

Legislation Against Use of Phosphorus

The introduction of white or yellow phosphorus as the principal explosive ingredient of the match head was generally claimed to be in 1831, adopted in Austria and Germany almost simultaneously, and from that time on, it was generally used throughout the world. White or yellow phosphorus is extremely poisonous, resulting in the phosphorus disease which affects the lower jaw bone and leads to necrosis, from which the workers, especially the dippers, were liable to suffer.

The manufacture of matches was often carried on in dirty, badly ventilated rooms, exposing the workers to every form of phosphorus poison. Conditions grew so bad that about ten or eleven years after the phosphorus match was invented, government investigations were being carried on throughout Europe, culminating in an explicit description in a paper presented by a Viennese in 1845. This exposé drove the match industry out of the cellars and created in many cases, improved conditions, such as, the closing-in of the machinery, exhaust and ventilating systems, dressing rooms, wash rooms with mouth wash, soap and towels furnished by the employer, and medical and dental inspection, with government inspection of the design of the factories. This had two effects. It improved conditions, and it surrounded the business with so many expenses that the business was soon in the hands of a very few.

Notwithstanding all these improvements and precautions, phosphorus poisoning continued to exist and no remedial measures were adequate enough to eliminate this most horrible and fatal poison. Consequently, Finland, which was one of the leaders of the match industry, enacted a prohibitory law, in 1872 against the use of white phosphorus in match factories. Denmark passed a similar law in 1874, but not until 1894 was the phosphorus ingredient prohibited in France.

In 1906 the *International Association for Labor Legislation* secured an international conference at Berne, which provided for the absolute prohibition, manufacture and sale of white phosphorus matches. This legislation was approved by Denmark, Germany, France, Italy, Netherlands, Switzerland, by Great Britain in 1908 and Spain in 1909. Austria, without joining in the conference, enacted a similar law in 1909, New Zealand and New South Wales in 1910, Hungary in 1911, Mexico in 1912 and Canada did so in 1914.

The details of this legislation are mentioned to indicate the length of time that it took with our form of government to have any prohibitory legislation in the United States. The delay was due to the fact that by the very nature of our Constitution, the fed-

eral government can not interfere with local conditions. However, in 1912, Congress put a heavy tax on white phosphorus matches and prohibited their importation after 1913.

Invention of Non-Poisonous Matches

In 1898, France and Belgium offered prizes to inventors of matches without the use of white phosphorus and the result was inventions by Sevene and Cahen of a non-poisonous phosphorus which was adopted by the French government and later, by all countries. This patent was obtained by the Diamond Match Company soon thereafter, and was held by it until it surrendered the exclusive rights to the use of this non-poisonous phosphorus so that all other manufacturers in the United States could use it, on the one condition that the United States government would make it prohibitory to use poisonous phosphorus.

This condition was complied with by the government through the tax heretofore mentioned, which eliminated, finally, the use of poisonous phosphorus throughout the world. However, it is interesting to note that legislation enacted in 1872 in Finland was finally adopted in the United States in 1912, forty years after the first European countries had adopted these humane and safety measures.

The "Strike-Anywhere" Match

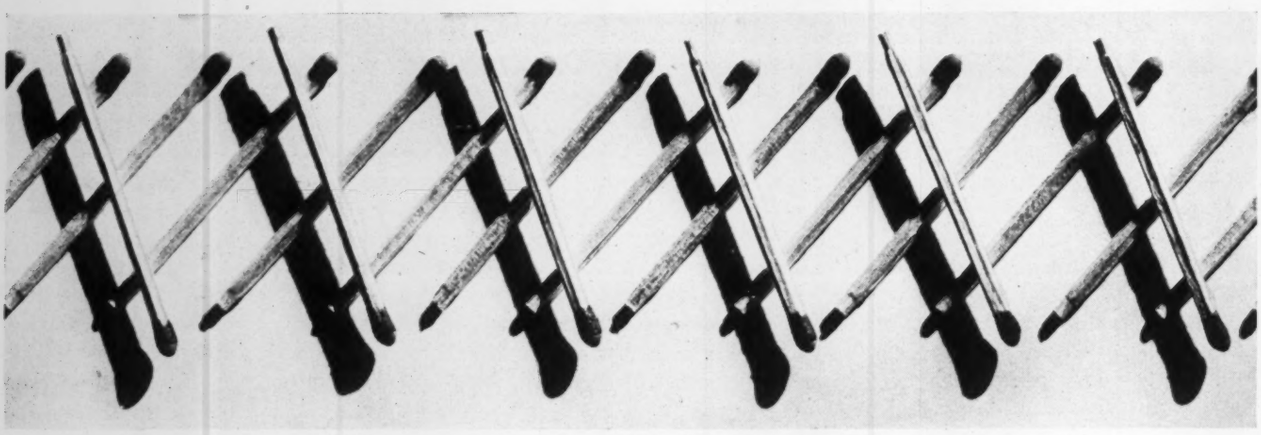
This match is made of splints, usually cut from aspen or basswood logs. These logs must be free from knots and sound at the core. The logs, after being barked, are cut into veneer of uniform thickness, and then vertical splitters cut the veneer into uniformly wide strips. In the usual machines, the veneer is fed on to the entering end of a conveyor and dipping machine, and is there split into proper width splints by an automatic machine, which presses the splints into perforated plates, which are carried on the conveyor.

An exhaust system is attached to the splitting head of the machine, and shavings and dust are carried from the machine room and disposed of either in the boilers, or in dust separators and bins. It is interesting to realize that all splints are tested for strength, and unless the proper number of samples withstand the dropping of a weight on the unsupported end, the splints are discarded.

Composition

The usual composition of "strike-anywhere" matches is as follows:—color, potassium chlorate, ground glue, kieselguhr, rosin, zinc oxide, phosphorus sesqui-sulphide and water. It is a fundamental precaution in the mixing of a composition for matches, to keep potassium chlorate and phosphorus sesqui-sulphide separate, as they form a very explosive mixture.

High-grade glue in ground form is placed in the bottom of a steam-heated kettle, and part of the necessary water is added, and the glue allowed to



cook for several hours. While the glue is soaking, the other ingredients are mixed and then transferred to the melted glue, and stirred. After about ten minutes of stirring, the phosphorus sesqui-sulphide, in paste form, is added. This is done to prevent premature firing. Then, after additional mixing, the composition is ground. The ground composition is then re-mixed, then re-ground and transferred to the composition pots of the match machinery. The large number of mixings and grindings tends to prevent hang-fire, a phenomenon which takes place, sometimes, when the finished match is struck where the tip fires satisfactorily, but the inert base is not heated sufficiently for functioning. In this case, the match appears to light up, but does not, and then suddenly bursts into flame. This phenomenon is also due to drying conditions. The ingredients and the methods of handling them just described refer to the inert base or bulb. The tip composition is handled similarly, except that more care is necessary due to the greater quantity of sesqui-phosphorus.

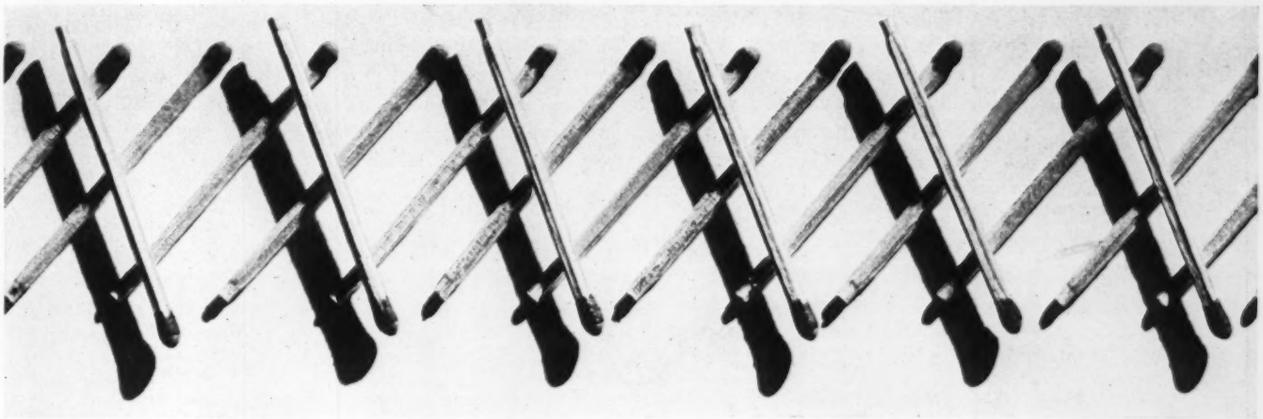
The Tipping Machines

The tipping machines, themselves, consist of a frame work of angle irons, supporting large cast-iron pulley wheels, over which endless chains or belts are carried. The belts consist of steel plates, perforated for the reception of the splints. The average plate holds approximately two thousand splints, and sufficient plates are installed in order to carry about a million matches in an hour. In the average machine the splitting of the veneer and the forcing of the splints into the perforated plates is done in a continuous operation.

The splints are put into an impregnating tank

where they are soaked in a solution of ammonium phosphate, which is heated to about 160 F. This is to prevent what is known as after-glow, and renders the splints partially fire-proof.

The manufacture of matches in the modern continuous process is a dipping and drying process. The steel belts holding the perforated plates dip down from a horizontal position so that at a lower level the plates are carried horizontally and the splints vertically, at exactly the proper level to pass through the various impregnating or dipping compositions. The splints, after being impregnated and dried by the action of propeller fans, which are made a part of the conveyor machinery, are dipped into melted paraffin which is kept at a temperature something over 200 F. The paraffin gives a "candle effect" to the splint, in which the wood acts in the nature of a wick. The paraffin is then dried in a manner similar to the impregnating solution, by being conveyed at a uniform speed and subjected to the action of air supplied by fans. At the proper point in the machine, the splints, now impregnated and paraffined, are sent over dipping rollers and receive the inert base composition.



Temperature and Speed Controlled

It is very essential that a uniform speed of machine be maintained, in order to obtain a uniform base for the tip. The pot in which the composition is held is kept at a uniform temperature by means of steam. About 100 F is the proper temperature for the dipping composition. The viscosity of the composition has a very great effect on the shape and size of the heads, and it has been determined that this viscosity is a function of temperature and humidity.

From the head-dipping operation, the plates are carried along for about one-third of the total distance, being carried horizontally and vertically by means of the conveyor, in order to give a sufficient drying period. This period is approximately thirty minutes. At the end of this time, the bulb has dried out sufficiently, assuming that temperature and humidity conditions are correct, to permit the application of the tip, without the danger of the two compositions running together. It is important that the tip be very thin.

After the matches are tipped, they are carried to the end of the frame work, and then in various ways, either after a complete return travel of the chain, or at some intermediate point, the matches are automatically removed from the perforated plates and are packed, usually by hand, into boxes for shipping. About four hundred matches are usually put in the ordinary "strike-anywhere" boxes and a gross of boxes in a case.

Proper Air Conditions

Without going into too much detail about the chemical reasons for air conditioning requirements in a match factory, we know from long experience that match factories require (for satisfactory operation), conditions not over 80 F dry bulb and preferably 72, and that a relative humidity of 50 per cent with these temperatures gives satisfactory drying conditions. There are probably more unusual conditions to meet in a match factory than in almost any other one air conditioning problem because two sets of conditions arise, having no relationship to each other, but each acting to upset each other.

Amount of Water Evaporated

We have stated that water is mixed with the ingredients to get the proper viscosity. Part of this water is taken up by the glue and part is evaporated to effect drying. It has been found that in the manufacture of a million matches from sixteen to twenty pounds of water must be evaporated. Therefore, if one match machine handles one million matches per hour, sixteen to twenty pounds of water per hour must be evaporated and carried away. This means from 1870 to 2230 grains per machine per minute. Assuming that the ideal condition for drying matches is 72 F and 50 per cent relative humidity, the grains of moisture per cubic foot that must be maintained in the air are approximately four. But 72 F dry bulb is almost as essential to proper match making as the moisture, because glue is variable in its viscosity with changes in temperature. As the match head is a mechanical mixture of various chemicals held in an emulsion, let us say, by the glue, a change in viscosity of the glue allows the chemicals to take other than the proper positions, which would make a badly shaped head or an inefficient explosive.

Conditions Must Be Controlled Exactly

Unlike a comfort problem, where slightly cooler or better conditions than those required may be a dis-

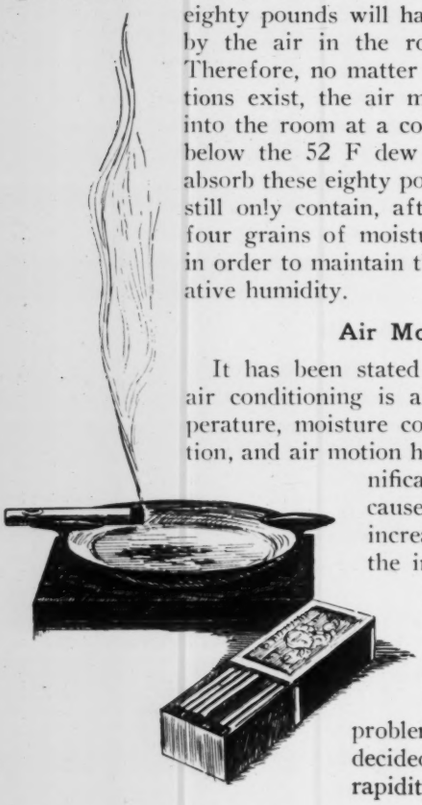
tinct advantage, different conditions in a match factory set up conditions that are deleterious for the matches. Therefore, an air conditioning system for match manufacture must be set to give ideal conditions for a maximum load of both moisture absorption and temperature, and if one of these maximums is not reached, compensation must be supplied even if it is done at a sacrifice of efficiency.

To illustrate the point, let us take a typical match plant installation in which four match machines, each capable of tipping and drying a million matches an hour, are installed. The room in which these machines are placed is the top floor of a factory building. As the average match machine is from seventy to ninety feet long, we will assume that the room is one hundred and twenty-five feet long and sixty feet wide, with an insulated ceiling, four exposed walls, and a good quality mill construction floor.

Let us assume that it has been determined by the composition of the match heads, or rather by the quality of the glue which the company has decided to use, that 72 F dry bulb and 50 per cent relative humidity, giving a 60 F wet bulb, is the ideal condition for the progress of the matches through the machine. This gives a 52 F dew point or saturation point of the air, and at that condition the air contains 4.4 grains of moisture per cubic foot.

Amount of Water Air Must Absorb

As a second assumption, we may assume, and this undoubtedly will be determined in the plant laboratory, that each million matches will have to be relieved of twenty pounds of water, so that the four machines under the maximum working conditions, would give up eighty pounds of water. As the average machine delivers a million matches an hour, this eighty pounds will have to be absorbed by the air in the room in one hour. Therefore, no matter what other conditions exist, the air must be introduced into the room at a condition sufficiently below the 52 F dew point in order to absorb these eighty pounds of water and still only contain, after the absorption, four grains of moisture per cubic foot in order to maintain the 50 per cent relative humidity.



Air Motion

It has been stated many times, that air conditioning is a problem of temperature, moisture content and air motion, and air motion has a particular significance in drying, because the rate of drying increases rapidly with the increase in velocity of the air over the object to be dried. As the making of matches is primarily a drying problem, air motion is a decided factor in the rapidity and uniformity of drying, and in almost every instance in match making plants, circulating fans to accelerate the drying are placed as an integral part of the dipping machine to supplement the movement of the air introduced into the room for maintaining the ideal conditions.

The maintaining of a relative humidity of approximately 50 per cent is essential because of the fact that if some external factor should permit the lowering of the relative humidity, the drying would undoubtedly occur too rapidly on the surface of the match head, upsetting the equilibrium of the vapor absorption from the head, and allowing the surface of the match to dry before the interior had given up its vapor. This is what is known in drying as case hardening, and the result of case hardening, particularly in the drying of glue, is that when moisture equilibrium is finally established, the surface of the dry article again becomes wet, and in packing matches in which the surface is hardened, the matches stick together, forming an imperfect and dangerous box of matches.

If the relative humidity is too high during the drying period, the capacity of the air for absorption is lessened, and the matches reach the end of their travel before they are properly dried, and the same result takes place, that is, matches stick together in the box. Not only that, but the four or five dipping operations which take place in the progress of the matches through the machine must be thoroughly completed, and the surface thoroughly dried before the next coating is applied. Also, the dry bulb temperature affects the viscosity of the glue, and there is that very definite temperature at which the flow of the glue is satisfactory for forming the evenly shaped tip desired by the manufacturer.

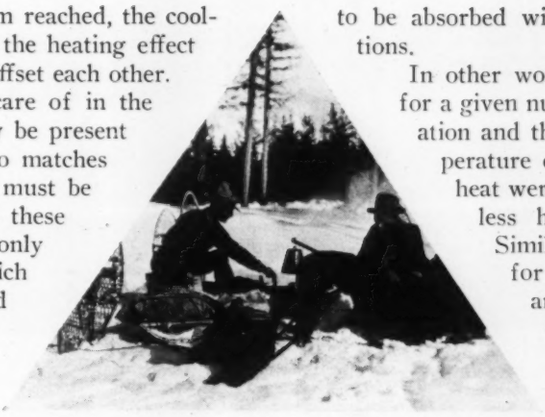
The Cooling Load

We can now return to the problem of a match making room in which established conditions are best for the production; in which a certain definite amount of moisture must be absorbed at a definite relative humidity; and in which the glue is of a particular viscosity at a definite dry bulb temperature. The factors entering into the maintenance of a definite dry bulb temperature, are those common to all air conditioning problems — transmission through walls and glass, through floors and ceilings, sun effect, heat of the baths required for melting the various ingredients, motor loads given off by the motors required to drive the machines and heat from the attendants of each machine. These, when added together give the Btu's that must be absorbed by the entering air in order to maintain the required temperature.

To illustrate, at this point, some of the additional difficulties of match conditioning, each pound of water absorbed by the air has a cooling effect of about 1,000 Btu's. Therefore, to add to the complications, with eighty pounds of air absorbed per hour there is a cooling effect equivalent to 80,000 Btu's.

As a five hp. motor is usually essential to drive the ordinary match machine and as about seven people are required to operate one machine, and as the full

capacity of the machine is seldom reached, the cooling effect of the absorption and the heating effect of the motor and people nearly offset each other. This, however, must be taken care of in the controls, because the people may be present and the motor running when no matches are being dried and the system must be flexible enough to take care of these conditions at any time. Not only that, but the various baths which must be kept constantly heated will give off heat to upset conditions even when the particular machine which they are serving is not in operation.



MATCHES MUST BE DEPENDABLE

Moisture Content of Entering Air

As we know the dew point in the room must be 52 in order to maintain 50 per cent relative humidity, we realize that the air must be brought into the room at a dew point not over that degree, and the absorption of the moisture from the match heads themselves, indicates that the dew point must be less than the maintained dew point in the room. Let us assume, then, for purposes of calculation, that the amount of air required to take care of the transmission and other losses would require fifteen thousand cubic feet of air a minute, and that ninety-two hundred grains of moisture have to be absorbed from the machines every minute. Then each cubic foot of air introduced into the room would have to absorb approximately 0.6 of a grain of moisture and instead of having 4.4 grains of moisture per cubic foot in the air introduced into the room, we can only have 3.8 grains, which requires a 48 F dew point.

This would mean that less air than the fifteen thousand cubic feet could be employed at those periods when the maximum number of machines was not in operation, but that at any time that the maximum number of machines was in operation, that dew point would be required, irrespective of the heat losses, or rather heat gains, and that if the variation in out-door conditions or motor loads were not sufficient to bring the introduced air to the required dry bulb temperature, that heat would have to be added for several reasons:

First, in order to give the 72 F required in the room, in order to keep the viscosity of the glue at the proper point.

Second, in order to maintain the proper relative humidity for satisfactory drying; to give sufficient drying capacity to the air.

This heat can be added by means of steam coils with a controller which would regulate the amount of heat required, actuated by the dry bulb temperature in the room. This introduces the element of inefficiency which has been referred to before, but there is no way to obviate this where the moisture to be absorbed and the heat to be absorbed bear no relationship to each other. In the mildest outside weather, when the heat to be absorbed is practically negligible, the evaporation from the match heads is constant and requires a definite dew point in order to be absorbed without affecting the room conditions.

In other words, if the dew point is constant for a given number of match machines in operation and the inflow of heat varies, the temperature of the room would be too low if heat were not added to compensate for the less heat coming from out-of-doors. Similary, if the system were designed for a maximum number of machines and a maximum outside condition of temperature and humidity, and the air volumes conditioned to meet these were fixed, either automatic control of the water temperature or automatic control of volume of air delivered would have to be installed or both would have to be correlated to give satisfactory results. Add to these troubles varying amounts of exhaust or make-up air depending on the amount of shaving exhaust for the splint splitters and one has a problem in the match industry hardly approached in any other.

Amount of Refrigeration Required

As temperature is so important in the match industry, refrigeration is required to maintain the necessary conditions in the summer time or whenever the outside wet bulb rises above the inside required dew point. Under maximum conditions of absorption and temperature about fifteen to twenty tons refrigeration effect is required per match machine.

This can be figured in the following manner:—

If 4,000 cfm of 45 F dew point air is required per machine, and a 60 F wet bulb is maintained in the room, and 25 per cent of the air must be replaced due to the shaving exhaust, and if the outside maximum conditions are 78 F wet bulb, then—

3,000 cfm @ 60° W.B. must be brought down to 45° D.P.
1,000 cfm @ 78° W.B. must be brought down to 45° D.P.
The total heat per lb. of air at 60° W.B. = 26.16 Btu.
The total heat per lb. of air at 45° D.P. = 17.60 Btu.
The total heat per lb. of air at 78° W.B. = 40.50 Btu.

The total heat absorbed by 3,000 cfm $= \frac{3{,}000}{13.3} \times 8.56 =$ 1930 Btu.

$\frac{3{,}000}{13.3}$ = lb. of air.

8.56 = difference in Btu of a lb. of air at 60° W.B. and 45° D.P.

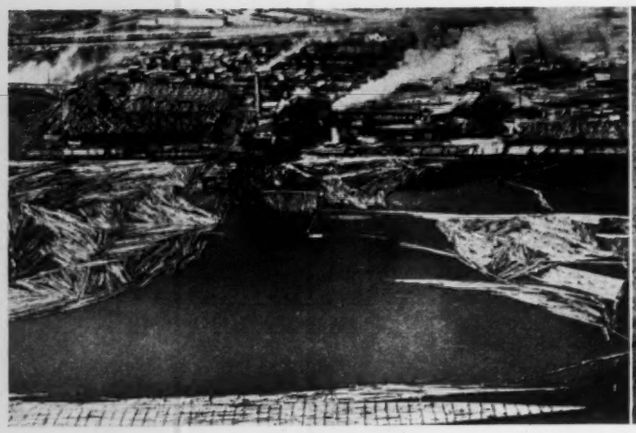
The total heat absorbed by 1,000 cfm $= \frac{1{,}000}{13.3} \times 22.90 =$ 1720 Btu.

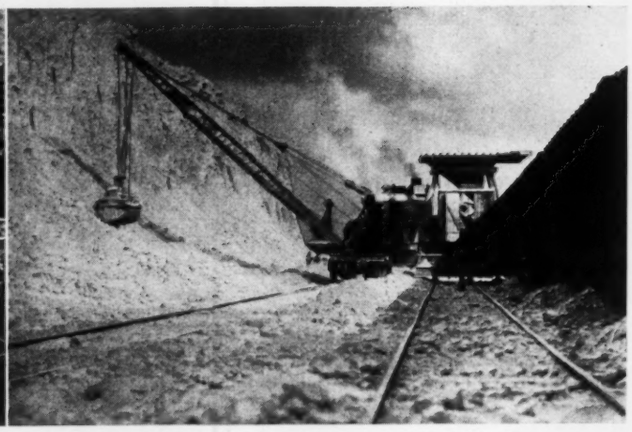
$\frac{1{,}000}{13.3}$ = lb. of air.

22.90 = difference in Btu of a lb. of air @ 78° W. B. and 45° D.P.

Therefore, total Btu's = 3,650.

There are 200 Btu per minute in a ton of refrigeration effect, therefore, $\frac{3{,}650}{200}$ = 18.25 tons required per match machine.





In some match plants where the circulating fans are not an integral part of the machines, fairly good results can be attained by large circulating fans in the room, creating a draft across the match machines.

The exhaust from the splitters, carrying a large amount of splints and dust, usually is discharged through a separator, the air being delivered out of doors or sometimes with the splints into the furnace.

The air conditioning apparatus proper frequently consists of a dehumidifier with the washer located above a tank in which cooling coils are placed. The washer or dehumidifier is usually of the three-bank spray type with eliminators at the entering and leaving ends, and the water dripping from the upper tank over troughs in the lower tank to be cooled by the refrigerant inside the stands or banks of coils. In an air conditioning job of this sort, the temperature of the refrigerant inside the coils is usually around 20 F to give 35 to 40 F water. This cooler water is then mixed with the water sprayed in the washer above, in quantities sufficient to maintain the leaving air temperature at the desired dew point of about 45 F.

The amount of water circulated is readily figured from the total heat to be absorbed by the cooling water and the rise in temperature allowable in the washer. This rise in temperature may vary from three to seven degrees, seldom less than three and not very often more than seven degrees. For the three-bank washer a twelve-foot washer is preferable to a shorter one and the washer is usually rather broad and shallow, in order to allow it to be placed over the baudelot tank.

Fans and Heaters

Fans and heaters, the heaters thermostatically controlled by the temperature in the room, and fresh and returned air dampers to control the volume of air are usually installed, although in many instances, the fresh air damper is hand-controlled. The same system which operates for conditioning in the summer time can be used for maintaining proper conditions in the winter, except that in the winter time it is not essential to operate either the dehumidifier or the refrigerating system. At this period of the year, the entering air having a very much lower dew point than that required in the conditioned room will act as the dehumidifier and when mixed with air returning from the room carrying an excess of moisture, will create ideal conditions for match drying. Of course, this air, under ordinary conditions in the winter time, must be re-heated just as it has to be re-heated in the summer time, the only difference being that the amount of re-heating for the winter is usually somewhat greater than in the summer.

Cost of Equipment in a Junior High School

Editor, Heating, Piping and Air Conditioning: This department has recently taken bids on a new junior high school building, the data of which we feel might be of interest to some of your readers. I am attaching herewith a tabulation of the low bids on each branch of the work. This tabulation shows the percentage of the total cost of each of the branches of the work, and also the cost per cubic foot. A total cost of 28.79 cents per cubic foot is a very reasonable figure, and includes the complete building, completely installed ready for operation, including all educational equipment.

Very truly yours,
Bureau of Buildings,
Board of Education, Minneapolis,
A. L. Sanford,
Mechanical Engineer.

Folwell Junior High School
Cubage 2,406,659

		Percent of total cost	Cost per Cu. Ft.
General Construction	369,900.00	53.6	15.43
Reinforcing Steel	21,889.00	3.1	.91
Hardware	8,000.00	1.2	.33
Miscellaneous Equipment	11,290.00	1.6	.47
Total General	411,079.00	59.5	17.14
Heating	52,415.00	7.6	2.19
Oil Burners	3,817.00	.5	.16
Ventilating Units	11,140.00	1.6	.46
Plumbing	38,540.00	5.7	1.62
Pipe Covering	7,491.00	1.0	.31
Vent Sheet Metal Work	11,474.00	1.7	.48
Temperature Control	11,400.00	1.7	.48
Electrical Work	29,645.00	4.3	1.25
Dumb Waiter	260.00	.0	.01
Total Mechanical	166,182.00	24.1	6.96
Educational Equipment	92,739.00	13.5	3.86
Architectural, Engineering and Inspection Service	20,000.00	2.9	.83
Grand Total	690,000.00	100.0	28.79

The Architect's Design *and* Heat Economy

By Emery Stanford Hall

TO BALANCE architectural design and heat economy, there must be enough heat so that every one that occupies the building shall be both comfortable and in condition so as to be most effective, and this, whether on work or pleasure bent.

Intelligent discussion requires a common understanding of terms. For the sake of clarity, I define as follows: architectural design is the art of solving the human building problem in a way satisfactory to the owner and not obnoxious to his neighbors; economy is the balance of expenditure with corresponding return; balance means that the efficacy of the architecture shall not suffer for the sake of the heating plant, nor should the heating plant be loaded excessively due to unwise architectural design. A satisfied owner is both comfortable in mind and body. Mental comfort is impossible when a man's works are annoying to his neighbors.

Our premise may be defined as a supply of enough heat, light, air, orderliness, quiet, proportion, and color harmony to make the occupants of the building wholly unconscious of any of these. Consummate skill in design makes the occupant of the building happy without his knowing why.

It is apparent that there must be sufficient air of proper condition and purity to maintain health for both physical and mental efficiency. Good lighting shall likewise be available in ample quantity to supply all of the needs of highly productive work. These practical conditions effectively met, there is still something lacking. The spiritual side of the human animal must be ministered to. Color, proportion, orderliness are all features essential to human comfort. There cannot be the highest degree of service production where the server is either in physical or mental distress. Not only the eye but the ear must be housed under proper conditions. Clanging sounds and annoying echoes are as injurious to efficiency as clashing color and ugly proportion.

All of these considerations are inter-related. Design, color, proportion, light and air, all may affect indirectly the character of the heating, and it is difficult for an architect to consider one without considering the other.

Principles of Heat Distribution

Heat loss is dependent upon the principles which follow: Other things being equal, the tendency toward heat loss inwardly or outwardly through the walls of a build-

* Architect, Chicago, Ill.

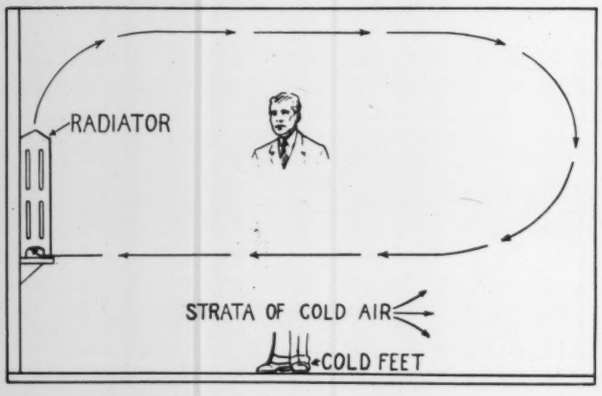
ing is directly proportionate to the difference in temperature between the inside and the outside. It makes no difference whether the inside is hot and the outside cold, or if the inside is cold and outside hot,—nature's first effort is to produce equilibrium. There can be no air equilibrium where there are different air temperatures at the same altitude. Neither can there be air equilibrium when there is warmer air below colder air. Effective enclosures must be designed to prevent air equilibrium between the inside and outside. Their primary function, from the standpoint of heat economy, is to block the tendencies toward air equilibrium. Their efficacy is dependent primarily on the perfection of their service in this particular.

Walls, floors, roofs, windows and doors are designed mainly as obstructions to the natural flow of air from inside to outside. They may be effective dams to flow, proportionate to the character of the material and its thickness. Given the same material, loss of heat is proportionate to thickness. For the purposes of this discussion, glass may be assumed to be the least efficient building material.

Heat distribution is effected practically on principles which follow: Warm air rises and cold air settles downward because warm air has a lesser specific gravity than cold air. Nature, in so far as air is concerned, is never at complete repose, except when the horizontal stratas of the air are of the same temperature, and the temperatures of the various stratas grade upward uniformly. Heating is made effective practically, through the medium of air circulation; therefore, the laws of air circulation are fundamental to a knowledge of heat economy. These laws are also essential to correct architectural design.

The principal practical factors that are involved in the balance of architectural design and heat economy may be arbitrarily fixed at say seven, which are summarized in the enumeration which follows:

FIGS. 1 AND 2—AN ENCLOSURE OVER A RADIATOR WILL ELIMINATE THE STRATA OF COLD AIR DIRECTLY ABOVE THE FLOOR IN MANY BUILDINGS



1. Enclosures—walls, floors, roofs, or ceilings, door opening closures and window opening closures.
2. Air supply—infiltration, vent ducts, etc.
3. Nature of occupancy.
4. Location of apparatus—high, low, remote, in the room, etc.
5. Humidity.
6. Shafts—stairs, elevators, rotundas, etc.
7. Esthetic consideration.

1. *ENCLOSURES*

(A) The Nature of Their Limitations

Enclosures have to meet certain conditions of practical occupancy. There shall be admitted enough light to carry on, to the best possible advantage, all interior processes of work, play, or what not.

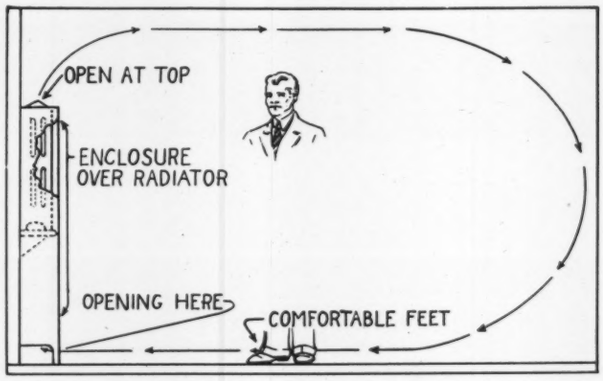
There shall be enough air admitted by infiltration through enclosures (if no mechanical method is provided) to supply all the respiratory needs of the occupants of the building.

There shall be no unnecessary loss of heat, but it shall be clearly understood that saving of heat at the expense of needed natural light may be a real economic waste.

(B) Types of Enclosures

Types of enclosures may be subdivided into two general classes—openable and/or transparent and opaque.

(1) *Transparent Enclosures* are generally movable and of glass, rarely of glass substitute. Doors, while not always of glass, are classed with glass since they represent practically the same heat hazard. Door and window closures are of necessity thin for practical reasons of operation and to facilitate light transmission, while opaque enclosures, having no particular reason for being thin, are usually made thick so that even with the



same type of material the enclosures classified as transparent or movable afford the principal area unit of heat loss. Movable parts employ joints which allow for air filtration without going through material. To cut heat requirements to the minimum, there should be no thin or movable closing parts. It would be much easier to heat a building without any windows or doors, than it is with them.

It is here that we have to go back to our original premise in order to find out what is economy. There have been many statements made by central station light producers, sellers of lighting apparatus, and others, to the effect that it is possible to produce artificial light to exactly approximate daylight. This is a problem for engineering analysis. The writer believes that, from a commercial standpoint at least, it advances a new problem. Were it already an accomplished fact, it would still be necessary to balance the cost of artificial light against the cost of sufficient extra heat to take care of the loss of heat through the necessary glass to

insure adequate natural light. At the present cost of artificial light, it is doubtful whether artificial light can compete with daylight through adequate window spaces.

This writer is positive in the view that no architectural design which does not provide ample unobstructed window area to furnish perfect daylight illumination to workers can be construed as entirely successful. Even with such adequate natural illumination, cloudy days and the short days of the winter force the using of artificial light longer than is best for high efficiency in work. What can not be eliminated must be endured, but let this period of partially satisfactory lighting be limited to conditions beyond the control of man. In contrast, where there is no exacting work requiring eye strain, to be carried on within the walls of the building, there is no excuse for large window areas. Architecture can not be considered as economical if it provides unnecessary window and door area.

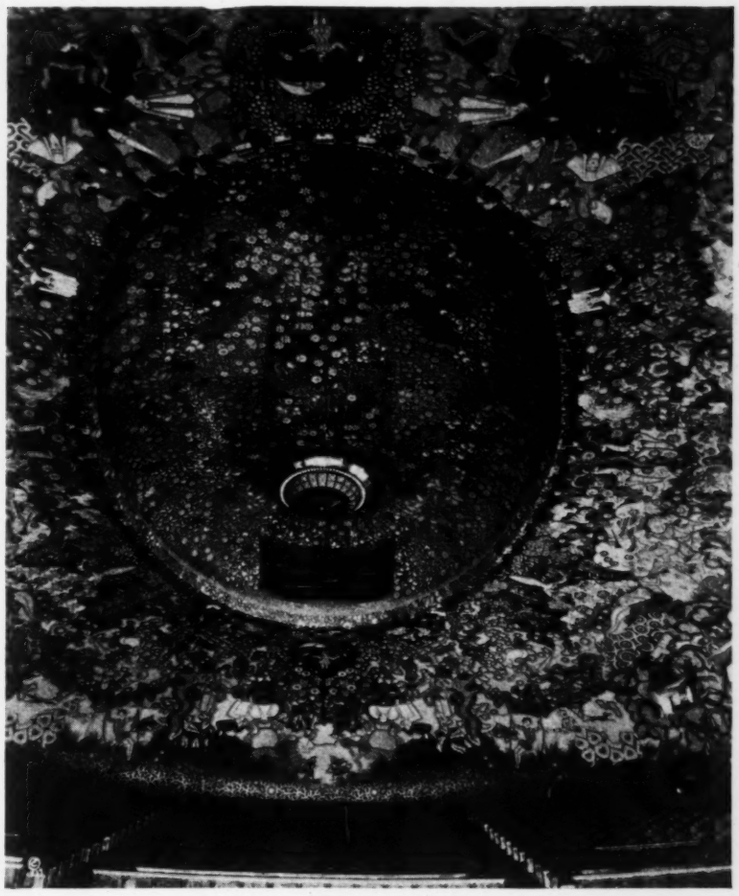


FIG. 3—THE DOME OF THE ZIEGFELD THEATER SHOWING THE MANNER IN WHICH THE AIR DISTRIBUTION OUTLETS WERE ARRANGED IN ORDER TO BALANCE THE DESIGN

We are instructed that loss of heat through a single sheet of glass is directly proportionate to its thickness, but that the same thickness of glass split up into two sheets set with an hermetically sealed air space between is very much more efficient as a heat-transmission-stop than the same material in a single sheet. A single sheet of ¼-inch thick plate glass seems to be twice as efficient as a heat transmission retardent as a ⅛-inch sheet of glass, but two sheets of ⅛-inch sheet glass with an air space between seem to be much more efficient than a single sheet of ¼-inch plate.

Sash with double glazing rabbets and glazing are very efficient heat savers, but may be light transmission retarders if the sheets of glass are not perfectly cleaned before setting, and the opening between is not hermetically sealed. Inflowing air currents always carry dust which will eventually coat the inaccessible inner surfaces of the sheets of glass. Separate storm sash, which can be opened and the glass washed separately on both sides, although not quite as efficient as double glazing in single sash, are more practical from a cleaning standpoint. Double, treble and even quarto glazing is much used in display refrigerator doors. Here it is practical to use more care in workmanship than is possible or practical in building window glazing.

Radiation through glass is not the only medium for loss of heat through windows. If the sheets of glass that make up a window or door closure are not properly back puttied or felt cushioned, it is impossible to make a perfectly air-tight joint between sash and glass by means of mere face puttying. Unless the glass is set air tight in the sash, there will be constant heat loss through air filtration around each sheet of glass. For practical reasons, the sliding or hinged opening joints around movable door or window closures must have play enough for easy practical movement. Air filtration through joints between closures and holding frames or walls can be greatly reduced by inter-locks and/or multiplied contacts with air spaces between. Anything to break up continuity of flow or uniformity of pressure has a tendency to retard or dissipate air currents. These principles are made use of in the design of weather-stripping, multiple-point-contact sash, etc.

Vestibuling or double door systems are efficient methods of cutting down air inflow at entrances. These can not be very efficient unless the outer door can be opened and closed before the inner door is opened. Their purpose is largely defeated when both must be opened at the same time in order to effect convenient entrance. A lock system such as is secured by the use of revolving doors is especially efficacious. With such doors it is impossible for the thoughtless person to open both the outer and inner door at the same time, and thus permit an inrush of cold air.

It will be readily realized that that portion of the building enclosure which is herein classified as openable and/or transparent is an especially important factor from the standpoint of economical building design when we recall that radiation is required for it in comparison with "opaque" wall areas, as at say 15 to 2. In other words, it takes 7½ times as much heat to take care of the loss of heat through a single square foot of window or door area as of a square foot of wall area. After a building is once heated, to maintain heat volume puts but little if any burden on the heating plant. All the real

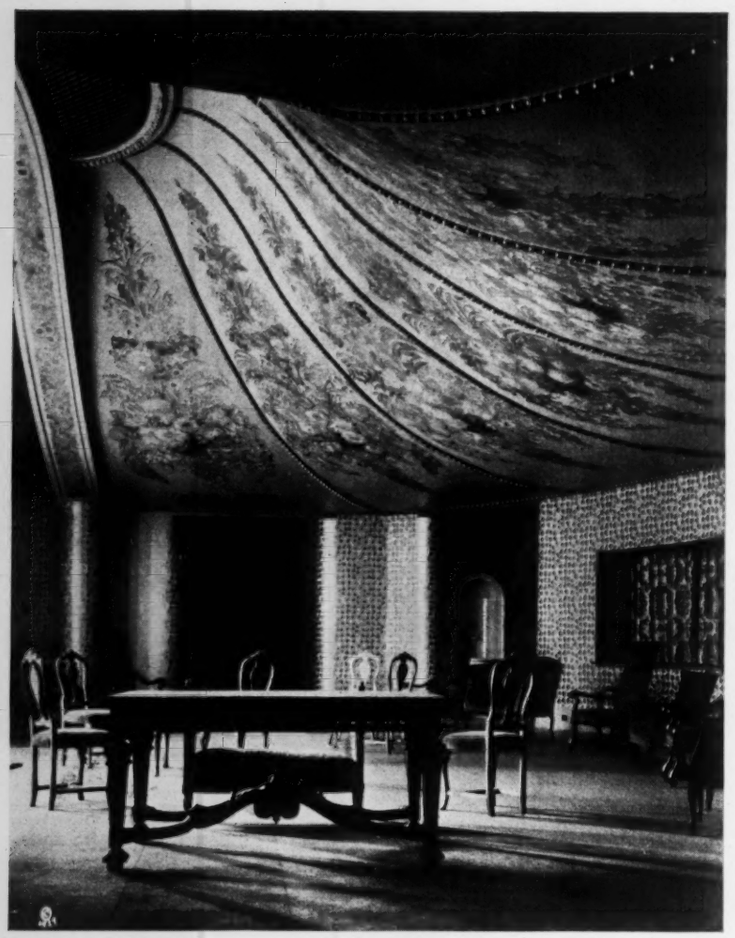


FIG. 4—THE MEZZANINE FOYER OF THE ZIEGFELD THEATER PRESENTED AN UNUSUAL PROBLEM IN BALANCING THE ARRANGEMENT OF THE VENTILATING EQUIPMENT WITH THE DESIGN

burden is supplying the loss of heat through enclosures.

(2) *Opaque Enclosures,* as herein classified, commonly known as walls, roofs, and floors, have no reason for movement and every reason for permanency in position. While such enclosures do not represent as large a factor of per-unit-of area heat loss as windows and doors, they actually are almost if not quite as large a factor in the complete building structure, because they usually represent by far the larger area.

Walls, floors and roofs are much easier to insure against unnecessary heat loss than are windows and doors. The permanent nature of their fundamental construction makes special treatment, to reduce heat transmission, easily practical. The liberal and correct use of permanently efficient insulating material is the solution of the problem of reducing wall heat transmission to the minimum.

We are very particular to insulate our ice boxes and coolers where the difference between extreme outside heat at 90 degrees F and inside at plus 34 degrees is only 56 degrees, but we neglect to insulate our building walls where the inside temperature is plus 70 degrees and extreme outside temperature may be minus 20 degrees, a possible difference between inside and outside temperature of 90 degrees. This difference is almost twice that which occurs between the inside and outside of ice boxes and coolers.

This writer once asked a self-styled packing house specialist what insulation he used on his brick cooler walls, and he said, "From 4 to 6 inches of cork; I should recommend 6 inches." He was then asked how much insulation he used on his smoke houses and he said, "2 inches of cork." He also stated that he considered plus 134 degrees to be the proper temperature to maintain in smoke houses. Note the inconsistency: the difference between minus 20 degrees and plus 134 degrees is 154 degrees. He would use 6 inches of cork on a wall on a variation of 56 degrees between the opposite sides of the coolers and 2 inches of cork on a variation of 154 degrees.

We may laugh at this so-called specialist's absurd practice, but are we much wiser? We use two or three layers of wood, and possibly an inch of cork, on our domestic ice boxes, with a differential of 46 degrees between a minimum inside temperature of 34 degrees and a maximum outside temperature of 80 degrees. At the same time, we think we have done remarkably well when we use, in a building, two layers of wood with thin paper between and one layer of plaster, or two layers of plaster, one of thin paper and one of wood only—this with a differential of 90 degrees between a minimum outside temperature of minus 20 degrees a required inside temperature of plus 70 degrees, almost twice the differential of temperature between the two sides of a building wall that there is between the two sides of an ice-box wall and no special insulating material. This is not in any sense an argument for less insulation in ice-box walls, but for more insulation in building enclosures.

Preconceived notion is the curse of every day practice. Every well trained architect and engineer knows better, but it is extremely difficult for him to overcome the inertia of the public. A public that is used to paying for its ice-box insulation and not used to paying for its building-wall insulation will fire its architect or its engineer if he specifies extra wall insulation, unless that public is first unsold of its present notion about economy in building. People have simply got used to waste here and not so much there.

The law of proportionate loss is the same whether the heat is inside or outside. Entrance of heat through its walls into a cooler is at exactly the same proportionate rate as loss of heat from a room to the outside. It is always based on two factors—ratio of relative difference in temperature inside and outside and on the coefficient of transmission for the various materials and form of assemblage of encasing walls.

(C) Acoustical Effect of Insulation

Perfect heat insulating material is certain to be perfect sound insulation material, since both heat and sound are carried through the medium of the air. Why have rooms, if not to insure privacy? What decent person wants to hear what his neighbors are talking about? There is an-

other very important factor in room comfort that is concerned with acoustics. The wall may stop perfectly all transmission of sound through it, but if the room has a hard metallic ring and resounds with echoes no one can work in it with comfort or the highest degree of efficiency. Heat insulation applied to the inner surfaces of such room walls will be just as efficient as wall insulation and will, at the same time, serve the double purpose of acting as a sound absorbent and kill objectionable echoes.

(D) Heat Exclusion

In tropical climates and during the summer season even in the temperate zone, it is as important to keep heat out as it is to keep heat in during cold weather. Here again, insulation is the answer. Let each room in a building be perfectly insulated, and the expert on air conditioning can deliver any kind of air condition needed. In every case, it is a question of perfecting enclosure.

2. *AIR SUPPLY*

(A) Sources of air supply are always outside of the enclosure, therefore, air supply is always of the temperature of the outer air. No occupied room can perform its proper function without a constant inflow of purified air and a corresponding outflow of vitiated air, the writer believes. The problem is how to admit this outer air without producing shock or other unnecessary disturbance.

(B) Methods of Air Admission are numerous and

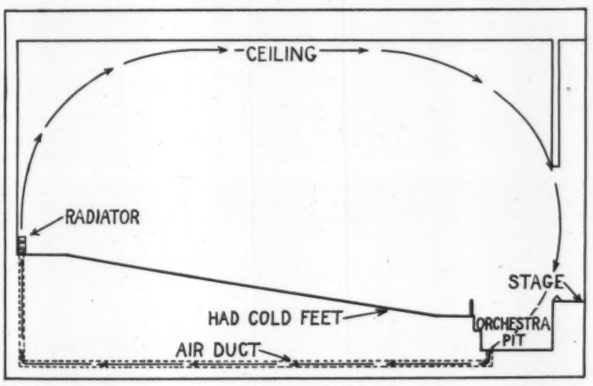
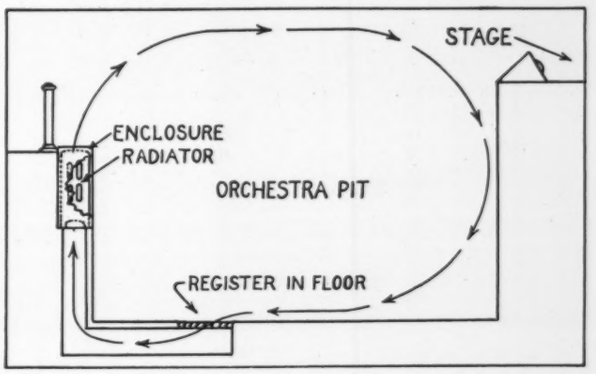


Fig. 5—(Left) The Installation of an Air Duct as Shown in This Diagram Removed the Cause for Complaints of Cold Feet

Fig. 6—(Below) Circulation of the Air in the Orchestra Pit of One Theater Was Improved by the Installation of a Duct as Shown



varied of application. The principal methods are enumerated as follows:

(1) Infiltration through walls of enclosure.

(2) Leakage through the joints around window sash, doors, etc.

(3) Direct opening through outside walls by windows, doors, etc.

(4) Duct conduits, etc., where the air is brought from a distance and discharged into the room.

(5) Combination where the air is brought in through ducts and discharged through windows and doors or where the air comes in through windows and doors and is exhausted from the room through ducts.

Discussing the various methods of air admission it must be conceded that within the practical limitations of building methods, 1, 2, and 3 are always in process to a greater or less extent even though method 4 is intended to be employed exclusively. Every building plan layout to insure comfortable occupancy, must provide for this condition. To insure perfect comfort, free from objectionable drafts, the infiltering and seepage air must be properly conditioned just inside the walls. Anything that tends to draw cold incoming air across the room before it is properly heated makes trouble for the occupants of the room. Therefore, sufficient radiation or other means should be provided in front of all windows and near all doors to temper air inflow. The duct method of course is ideal, with the air cleaned, properly tempered and humidified outside the room. If this method is used, it is up to the architect to so plan and detail as to make adequate provision for ducts without marring architectural effect. Registers should be ample, so located, and of such design, as to be decorative as well as practical. This means forethought.

3. *NATURE OF OCCUPANCY*

Mechanical and Animal Heat; Age; Clothing. It makes a lot of difference how a building is occupied as to the load on the heating plant. If there are heat producing mechanisms in the room, either mechanical or animal, such heat contribution should be considered. Anything of a heat consuming nature in a room requires more heat. Persons moving about need less heat than those forced to sit continuously in one position. Age and vitality are factors. Day by day, lack of clothing is getting to be more of a factor. If the feminine desire for anatomical display continues, heat demand will increase and the clothing man had better drop his craft for the heating business.

4. *LOCATION OF APPARATUS*

(A) Direct Radiation units should be placed low, in front of windows and near doors, for reasons as previously explained under "heat distribution." Where direct radiation can not be located low for any practical reason, then it can be made reasonably efficient by encasing the sides and extending the

encasement down to two or three inches above the floor. This method will force this circulating air to go down to the floor in order to find passage to the base of the radiator and as the cold air is removed from the floor, warmer air will be drawn down to take its place.

FIG. 7—THE AIR DISTRIBUTION EQUIPMENT OF THE ROOF GARDEN OF THE HOTEL GIBSON, CINCINNATI, HARMONIZES WITH THE ARCHITECTURAL DESIGN

(B) Recirculating Indirect Radiation places the source of radiation outside the room, draws the cooled air from the room, and returns the warmed air to the room through ducts. In order to avoid objectionable drafts, the cooled return air must be collected from just in front of each window and door. One reason why some warm air furnace and indirect recirculating steam jobs have proved unsatisfactory is because, in order to cut cost, they have been installed with only one cold air return and this located in the center of the building. Since cold air returns extend downward, it is but natural that the coldest air in the room rushes towards it and in doing so, travels close to the floor and quite possibly over the feet of the occupants of the room. Now if there were no floor space between the source of the coldest air and the cooled air return duct, there would be no floor on which feet could stand in the line of cold air return and, therefore, no heating plant cause for cold feet.

(C) Indirect Radiation and Outside Air Supply. With indirect radiation and air supply from outside the room, perfectly designed, it is possible to supply each occupant of a room with just the right amount of washed clean air at just the right temperature. If the feed ducts are made just a little larger than the exhaust ducts and the feed air given just a little more pressure than the outside air, it is also possible to stop practically all inseepage and infiltration of outside air, thus barring entrance of air-carrying dust, dirt and cold drafts. The objection to this system is that the incoming air must be heated to a considerable degree, to a higher temperature than the temperature of the room. This causes the feed air to rise to the top of the room upon entrance and in order to warm the floor it is necessary to draw it down to the floor by exhaust duct outlets near the floor. This method may produce objectionable circulation in the room and cause the double breathing of the same air, first on its up-flow and again on its down-flow. From the standpoint of cost, this is the most expensive method since the ducts must be excessively large in order to supply sufficient air to heat the room without heating the air to too high a temperature.

(D) The Combined System, with direct radiation in the room and air supply for respiratory requirements washed and heated outside and delivered to the room through ducts at the required room temperature, is often desirable. A system of this kind is very elastic.

In mild weather, the fresh air duct supply may be shut off and window-admitted fresh air supply substituted. Foul air exhaust may be taken from near the top of the room and on the corridor side thus removing the rising vitiated air which is breathed out at a temperature near 98 degrees without having it drop back in its course to be breathed again. When this system is practically applied, the architectural design must be so arranged as to permit the installation of air inlet discharge ducts with outlets under the windows or close beside them. This arrangement is necessary so that the ventilation through the windows and through the ducts shall travel the same route after entering the room. The "combined system" also possesses another advantage in that the expense of the ventilation can be cut off when the room is not occupied. It should never be forgotten that it costs a considerable amount of money to take air from the outside, condition it and supply it to the various rooms of a building. If it is recalled that most rooms are not fully, if at all,

occupied for more than 8 hours of each 24 it will be seen that with this system, ventilation cost may be eliminated for at least two-thirds of the time.

(E) Cooling in hot weather can be yoked with either the "indirect" or the "combined systems" using much of the same apparatus.

5. *HUMIDITY OF ROOM AIR*

Relation of Temperature, Humidity and Comfort: Temperatures required for comfort are very much dependent on the humidity of the air in a room. Tests show that school children are better satisfied with temperature, less restless, and more efficient with the air of the room of proper degree of humidity and a temperature of 68 degrees than they are with dry air and temperature of 75 to 80 degrees.

6. *STAIR AND ELEVATOR SHAFTS*

Elimination of Objectionable Drafts: Shafts are a fruitful architectural source of heat requirement discontent. They should be avoided wherever practical and ingeniously compensated where unavoidable. We need stair shafts and elevator shafts for reasons of communication, but there is no practical reason why these openings should not be closed with solid doors rather than open grilles. The open stair, so dear to the architect's fancy, must go in the interest of heat comfort.

As has been so frequently reiterated in this article, warm air will "up" and cold air will "down." In this process, objectionable drafts through shafts are sure to be created. The upper floors will rob the lower floors and the upper rooms will be too hot and the lower rooms too cold.

The open rotunda capped with an imposing lofty dome is a dignified architectural expression. There are occasions where nothing else can take its place. Let it be used but see to it that rooms and corridors are shut off from it on all floors and that balconies are purely decorative, or for observatory purposes and not used to serve as access to rooms.

7. *ESTHETIC CONSIDERATIONS*

Some Practical Factors: "Practical factors" essential to comfortable and healthful heat distribution have been discussed here at some length. Their importance can not be disputed, but because a thing is practical is no reason why it should be ugly.

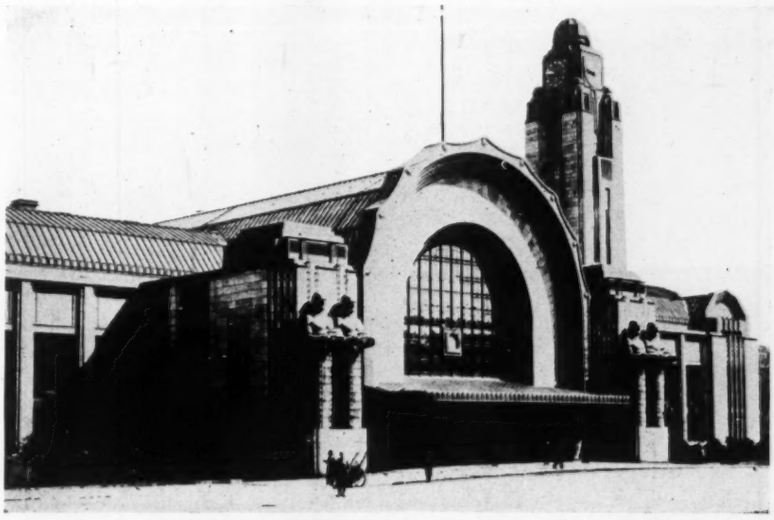
Radiators

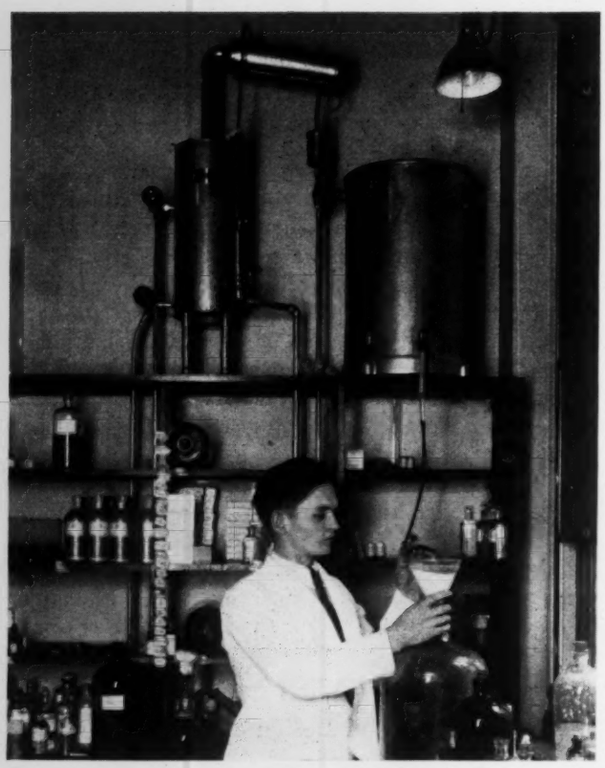
Radiators are a part of the program of heat distribution. They have an important utilitarian purpose to perform. Anything that has an essential duty in building economy can be successfully treated architecturally. The art of architecture is the pleasing and practical design of all of the required parts of correct housing. We do not need to be ashamed of anything that is really needed in building. Radiators are efficient in front of windows,—no apology should be expected for placing them there. They should have due consideration in the design of the window embrasure. If so considered, there is no good reason why they can not be made things of beauty as well as of comfort. One man lets his radiators happen, another seizes on them as an opportunity for ingenious artistic expression. Deflectors above radiators meet an important practical need. Why not design them to make a pleasing expression of their useful function?

Placing and Design of Grilles

Grilles are needed for room openings to air ducts. They may tell, in wrought metal, the romantically fascinating story of air service to man. All that is needed is dream power. It is air that carries the life-giving oxygen which fuels our bodily furnaces. It is air that, properly harnessed, distributes needed heat and cool, refreshing breezes. It is through the medium of the air that all of the subtle charm of speech is carried from man to man. The marvels of masterly musical compositions would be lost without the carrying power of the air.

The mere placing of grilles in a carefully studied grouping may make the commonest sort of plain square pattern registers appear to blossom with beauty. Beauty is orderly fitness. The ugliest sort of hieroglyphics symmetrically placed in accord with a carefully thought out design may produce a charming effect.





Helpful information on the various types of water sterilizers and distilling outfits is given in this article. The engineer who is to install such equipment in hospitals, laboratories, schools, or emergency hospitals in industrial plants will find many valuable hints on installation and operation here.

FIG. 1—STEAM HEATED SINGLE WATER STILL INSTALLED IN A HOSPITAL. IT HAS A CAPACITY OF 5 GALLONS PER HOUR, AND DELIVERS WATER TO A 15-GALLON STORAGE TANK

Selecting Sterilizers

Article No. 3

By Rollo E. Gilmore*

Central Water Sterilizers

CENTRAL water sterilizing plants have been in use for a good many years, but they have been improved with temperature control. They are often located with the power plant equipment or in the penthouse or top floor of a building. The top floor or penthouse arrangement affords gravity flow to various outlets on the floors below and decreases the amount of horizontal cross-piping.

It requires regular checking to keep surgical water sterile in the supply pipes and frequent thorough steamings. Occasionally this equipment is used only as a primary water sterilizer and this single-sterile water is piped to a secondary water sterilizer for secondary sterilizing. One tank is used as the main sterilizing tank in which the water is heated; the second tank is known as the tempering tank. The third tank is the reheating tank, in which the water is reheated to approximately 180 F and the fourth is the cooling tank in which the sterilized water is cooled to the correct temperature for the cold sterilized water supply.

The cooling tank first receives the water supply to the sterilizers and serves as a primary heater for the water to be sterilized, and this water also serves to cool the sterilized water. From the cooling tank the primary water travels through the reheating tank to the tempering tank, from which the water is connected to the main sterilizing tank.

A typical arrangement of central water sterilizers is illustrated in Fig. 2. The main sterilizing tank shown has a capacity of 300 gallons of water per hour at 280 F. In connection with central water sterilizers it is advisable to have automatic recording devices for the purpose of keeping a graphic record of the steam and water temperatures at all times. For piping sterile water throughout a building, pure block-tin-lined steel pipe or pure nickel pipe with similar valves and fittings is usually recommended.

Saline Apparatus

A saline assembly consists of a special water still, equipped with a saline storage tank, with mixing valve, chamber, etc. The saline solution should be maintained at a constant temperature of 110 F, 24 hours per day, as there is no telling what time of day or night saline solution may be required.

Saline requirements are sterility, freedom from sediment or cloudiness, and uniformity. Usually this can not be fully realized, as the salt in the saline solution attacks and causes a sediment to be dissolved from the inner

* President, Chicago Association of Consulting Engineers; engineer, Schmidt, Garden & Erikson, architects.

surface of various tank materials, or the tinning from the coils, and mix with the solution drawn off. A glass flask is a safe procedure, although it is reported that another method has been tested out that has proven practical, but details are lacking.

Water Stills

Chemically pure water is procurable only through distillation by means of suitable water stills. Neither filtration nor sterilization entirely meets the present day safety requirements, based on the *U. S. P.* standard, with reasonably high bacteriological purity. Distilling is required for producing soft and pure water suitable for the hospital, sanitarium, school, university, college, the chemical, pharmaceutical, technical or photographers' laboratory, for battery plants, garages, mirror plants, dye works, bleacheries, manufacturing plants, and sometimes drinking water systems.

For the more exacting hospital and laboratory needs, such as intravenous work, single distilled sterile, double distilled sterile, and sometimes triple distilled sterile water is advisable and usually demanded. The use of this double and triple distillate is generally for solutions including saline solutions, colloidal gold solutions, glucose solutions, tetra-iodo-phenolphthalein solutions and arsphenamin. Other uses for distilled water are for all solutions employed in injections; in connection with the operating department for dressings, irrigations, washing of wounds and instruments; in the drug room for compounding all pharmaceutical preparations, for diluting alcohol, and for preparations such as tinctures and syrups; and in the laboratory for making up bacteriological stains and other chemical uses.

The double and triple distilling equipment consists, in general, of two or three complete stills into which the raw water is fed to the first still producing single distilled water which is in turn fed to the second still, producing double distilled water which is in turn fed to the third still which produces triple distilled water. Sometimes a large central steam heated still is installed and is equipped with a distilled water storage tank. The single distilled water is then piped throughout the hospital or laboratory departments, and if desired, may be again distilled previous to use. The modern installations often use the built-in concealed mounting where the distilling apparatus is placed behind a wall in an equipment room with the operating valve stems and handles extending through, operated from the working room.

Water stills are made of the plain or open type for the hospital or laboratories, and the vacuum type for special processes requiring large capacities. In the plain still the liquid is distilled under atmospheric pressure and in consequence the boiling takes place at 212 F, or at whatever the natural boiling point of the liquid may be; this sometimes produces certain gases which are harmful and which are not produced in the pressure apparatus.

Types of Water Stills

The still may be supported either from the floor or bracketed from the wall. The type and capacities of distilling apparatus required in connection with laboratories and surgical, chemical and pharmaceutical demands vary according to the standards and daily and weekly demands of the individual hospital or laboratory, for purity of water, and to some extent according to the analysis of water to be distilled.

For a hospital of 100 beds and two operating rooms, usually a still of 3 to 5 gallons per hour furnishes suffi-

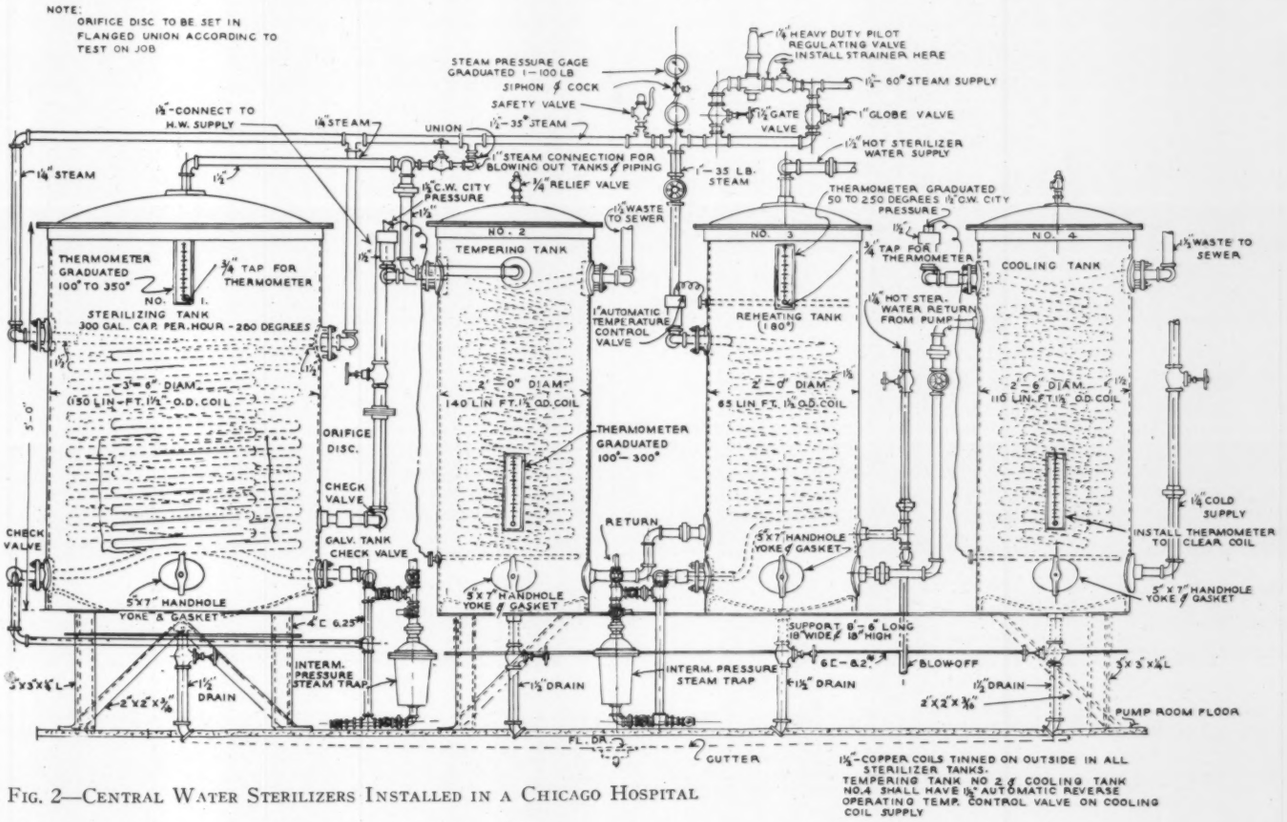

NOTE: ORIFICE DISC TO BE SET IN FLANGED UNION ACCORDING TO TEST ON JOB
STEAM PRESSURE GAGE GRADUATED 1–100 LB
SIPHON & COCK
SAFETY VALVE
1¼" HEAVY DUTY PILOT REGULATING VALVE INSTALL STRAINER HERE
1½" 60# STEAM SUPPLY
1½" GATE VALVE
1" GLOBE VALVE
1½" HOT STERILIZER WATER SUPPLY
1½"-CONNECT TO H.W. SUPPLY
1¼" STEAM
UNION
½"-35# STEAM
1" STEAM CONNECTION FOR BLOWING OUT TANKS & PIPING
1"-35 LB. STEAM
1½" C.W. CITY PRESSURE
¾" RELIEF VALVE
1½" WASTE TO SEWER
THERMOMETER GRADUATED 50 TO 250 DEGREES
1½" C.W. CITY PRESSURE
THERMOMETER GRADUATED 100° TO 350°
¾" TAP FOR THERMOMETER
NO. 1. STERILIZING TANK 300 GAL. CAP. PER HOUR - 250 DEGREES
NO. 2 TEMPERING TANK
NO. 3 REHEATING TANK (180°)
NO. 4 COOLING TANK
¾" TAP FOR THERMOMETER
1½" WASTE TO SEWER
1" AUTOMATIC TEMPERATURE CONTROL VALVE
1½" HOT STER. WATER RETURN FROM PUMP
3'-6" DIAM. 130 LIN. FT. 1½" O.D. COIL
2'-0" DIAM. 140 LIN. FT. 1½ O.D. COIL
2'-0" DIAM. 65 LIN. FT. 1½ O.D. COIL
2'-6" DIAM. 110 LIN. FT. 1½ O.D. COIL
5'-0"
ORIFICE DISC.
CHECK VALVE
GALV. TANK CHECK VALVE
THERMOMETER GRADUATED 100°–300°
RETURN
1½" COLD SUPPLY
INSTALL THERMOMETER TO CLEAR COIL
CHECK VALVE
5"X7" HANDHOLE YOKE & GASKET
5"X7" HANDHOLE YOKE & GASKET
5"X7" HANDHOLE YOKE & GASKET
5"X7" HANDHOLE YOKE & GASKET
4"C 6.25#
SUPPORT 8'-6" LONG 18" WIDE & 18" HIGH
6"C-8.2#
BLOW-OFF
5"X3"X¼"L
3"X3"X¼"L
2"X2"X¾"
1½" DRAIN
INTERM. PRESSURE STEAM TRAP
1½" DRAIN
INTERM. PRESSURE STEAM TRAP
1½" DRAIN
1½" DRAIN
2"X2"X¾"
PUMP ROOM FLOOR
FL. DR.
GUTTER
1½"-COPPER COILS TINNED ON OUTSIDE IN ALL STERILIZER TANKS. TEMPERING TANK NO. 2 & COOLING TANK NO. 4 SHALL HAVE ½" AUTOMATIC REVERSE OPERATING TEMP. CONTROL VALVE ON COOLING COIL SUPPLY

FIG. 2—CENTRAL WATER STERILIZERS INSTALLED IN A CHICAGO HOSPITAL

cient distilled water. Standard still units are made from one-half gallon up to one hundred and fifty gallons per hour and special multiple effect evaporator designs are used and have been made up to 5,000 gallons per hour.

Stills are designed for heating by gas, electricity, steam, oil, kerosene, gasoline, etc. The larger sizes above ten gallons usually are only made for heating with steam having a pressure of 15 lb., or more. Full automatic control may be had so that the still is operated automatically through a governing device which actuates control valves by a pre-determined level in the storage tank. Water distilled in the atmospheric pressure type, at a temperature of 210 F, at the elevation of Chicago, is not sterile and is unfit for intravenous work unless sterilized in an autoclave at 260 F. Water distilled in a water still that has been operated at 260 F is sterile, inert and preferable in every way for solutions used in staining slides in the laboratory.

Operation of Stills

The operation of a water still is usually continuous when the water supply is constant and the heat uninterrupted. The water supply in many types flows in at the bottom of the condenser, where it rises sufficiently in temperature to pass out in a partially purified state, as it throws off a large portion of dissolved gases. From this point the water enters the boiler or vaporizer where the heat is applied and the water is quickly vaporized. The steam passes off to a condenser where it is cooled, usually, by the in-flowing water rising around it and condenses so that it flows out as chemically pure distilled water, free from mineral and organic matter, either in suspension or solution.

In some stills the condenser is vented so that when the condenser is run hot and the steam is not all condensed, any residual traces of gases coming over with the steam are vented out and do not re-dissolve in the distillate. The raw condensing or cooling water from the still, heated to a temperature of about 190 F, is from 5 to 10 times the amount of distillate. It is often advisable, when stills are used almost continuously, to use this water in connection with boilers or other plant operation.

Distilled water is extremely active and will dissolve ordinary glass, so this type of container should not be used where the highest quality of distilled water is desired. Before a still is furnished by manufacturers the district revenue office requires the filing of an affidavit, in triplicate, bearing notary and seal, from the purchaser of the water still, since the passage of the 18th Amendment and the Volstead Act, Treasury Decision No. 308, before they will issue a permit for shipment of a still.

Stills in Conjunction with Pressure Type Sterilizers

Water stills are also made and arranged to attach and operate in conjunction with the pressure type water sterilizers, and are usually rated from one up to five gallon capacity. They utilize the excess steam present in each reservoir after sterilization and convert it by condensing into distilled water. Such distilled water, however, analyzes low in purity, as it carries a high gaseous content and, therefore, is limited in its use. The tanks are usually constructed of seamless drawn brass, block tin-lined. The condensing coils are usually made of copper, block tinned on exterior surfaces and all pipes and valves on interior surfaces leading to or from the still. The equipment or trimmings includes a steam inlet valve, cooling water valve, vacuum breaker, filtering air valve, sanitary bell-protected draw-off, water gage glass fittings or equivalent, drain valve, overflow, etc.

Storage Tanks for Distilled Water

It is often advisable to provide a distilled water storage tank holding from five to ten times the hourly capacity of the water still. Cylindrical tanks for storage of distilled water usually are built of extra heavy cold rolled copper, block tin-lined inside, equipped with gage glass, overflow, and handhole. The interior of the storage tank should be kept sterile and a steam coil in the tank is recommended so as to boil up and sterilize the tank or its contents at any time. The pipe and fittings, such as elbows, tees, unions, couplings, faucets, or spigots, etc., should all be block tin-lined, or nickel pipe. Tinned brass tubings and fittings are less expensive and accepted by some to be equally safe. Faucets of the self-closing type, silver-plated inside, are to be had. Storage tanks are fed by gravity from the outlet of the still through special piping, and may be supported from the wall with suitable wall brackets or from the floor on wrought iron or steel floor stands.

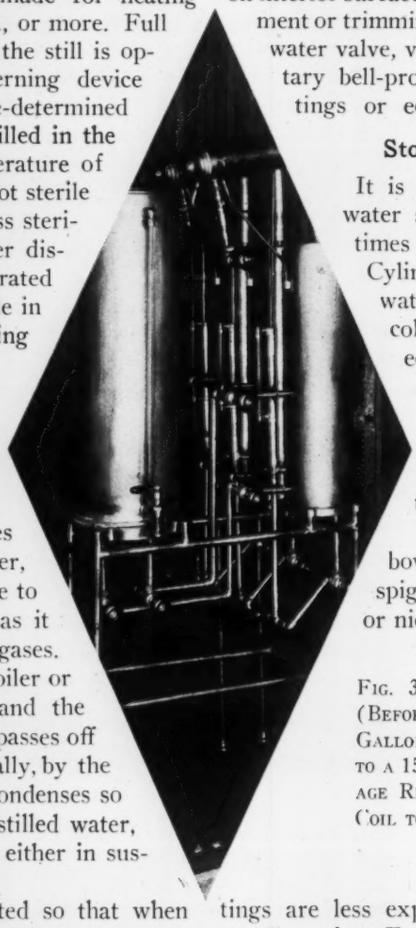


Fig. 3—Triple Distilled Water Outfit (Before Being Nickel Plated) of a 5 Gallon per Hour Capacity Discharging to a 15-Gallon Storage Tank. The Storage Receiver Is Equipped with a Steam Coil to Sterilize the Tank and Its Contents Periodically

Steam, Gas, or Electric Consumption

For distilling water with steam heat a minimum of ten pounds pressure is desirable, although some will operate as low as five pounds pressure but at reduced capacity, while others are recommended for heating with 35 to 70 pounds steam pressure. Theoretically, approximately 9 pounds of steam per gallon of distilled water is required, although in actual practice the figure is conservatively 9½ pounds of steam per gallon of distilled water.

Steam heating is an inexpensive method of operation, as the cost runs as low as one-half cent per gallon, while gas heat gives a minimum cost of approximately two cents per gallon. With gas heat, approximately 18 cubic feet of artificial gas or equivalent will be required per gallon of distillate produced. Electrically heated stills are usually adopted because of convenience, but their cost is usually many times that of either steam or gas,

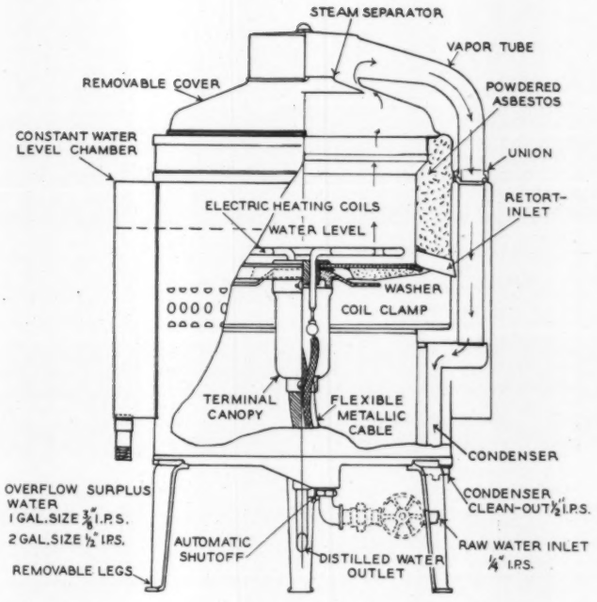


FIG. 4—AN ELECTRIC HEATED WATER STILL OF ONE OR TWO GALLON CAPACITY

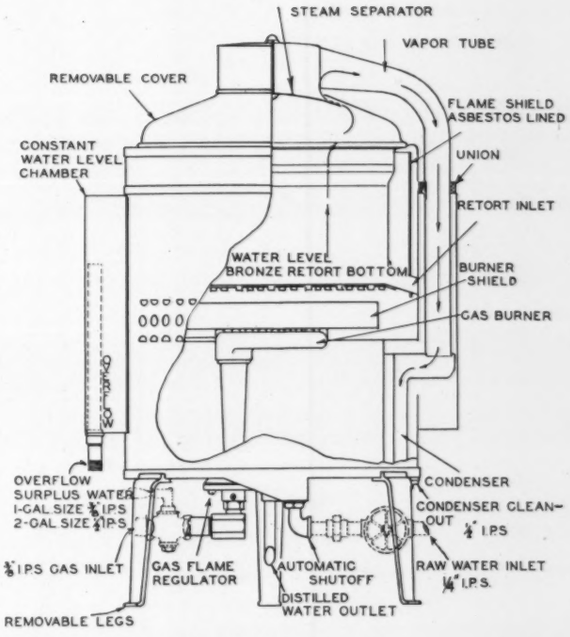


FIG. 5—A GAS HEATED WATER STILL OF ONE OR TWO GALLON CAPACITY

depending upon the local current rates. For distilling water with electric heat approximately 2.4 kw-hr. per gallon of distilled water is required, which at one cent per kw-hr. would be approximately two and one-half cents per gallon, or if three cents per kw-hr., would be approximately seven and one-quarter cents per gallon.

Non-pressure Type Laboratory Sterilizers

The sterilizers, sometimes referred to as the Boston Board of Health (or Arnold) pattern, are of the non-pressure type, and for laboratory use are designed both in the vertical cylindrical and rectangular form. A small size, designed for sterilizing milk, maintains an unvarying temperature of 100 C in all parts of the sterilizing chamber, without attention except replenishing of water occasionally.

The sterilizers are equipped with single or double side doors, and with single or double walls; and may be arranged with both single and double compartments as desired, and with two or more removable perforated shelves and quick steaming bases. They are, however, usually heated by means of gas burners or electric heating elements as desired.

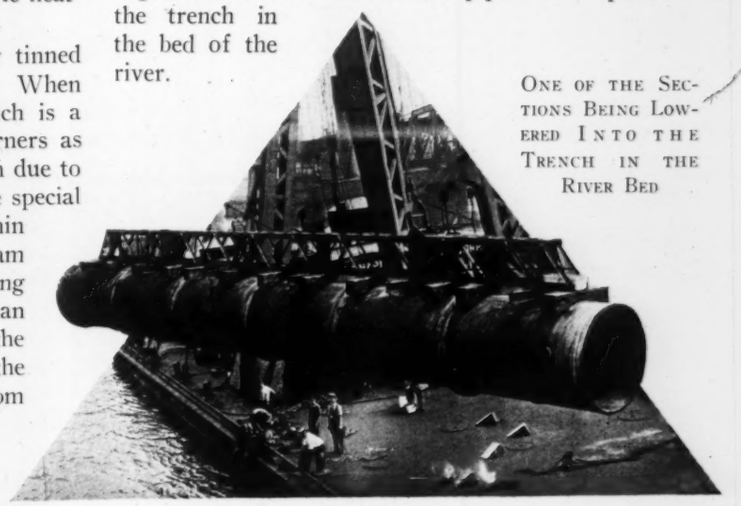
The construction usually consists of a heavy tinned copper bottom or all heavy polished copper. When desired the base is enclosed in sheet iron, which is a convenience in laboratories using individual burners as a source of heat, and prevents irregular operation due to the influence of drafts on the burner flame. The special construction is so designed that only a very thin layer of water is kept boiling, causing the steam which forms rapidly to rush into the sterilizing chamber under a slightly higher temperature than that of boiling water. Water from the base of the upper chamber is automatically supplied to the boiling chamber. The steam, after escaping from the sterilizing chamber, passes into a space between the walls of the chamber and the hood and is forced down, coming in contact with air above the water reservoir, where it condenses and drips back to be used again. These sterilizers are made in the following approximate inside dimensions:

Width Inches	Depth Inches	Height Inches	Remarks
8¾	9	14¾	One double door
12¼	12¾	15¼	One double door
16½	14½	19½	One door
15¼	24½	12½	Two double doors

In addition, vertical cylindrical types are made in various sizes.

Largest Cast Iron Pipe

The largest cast iron pipe ever manufactured was used in the construction of a telephone subway under the Harlem River, according to the New York Telephone Company. The sections were made of six 12-ft. lengths, calked together on the deck of a floating derrick and then bound to a beam for rigidity during placing. Divers using pneumatic tools forced the lead wool calking between sections after the pipe was in position in the trench in the bed of the river.



ONE OF THE SECTIONS BEING LOWERED INTO THE TRENCH IN THE RIVER BED

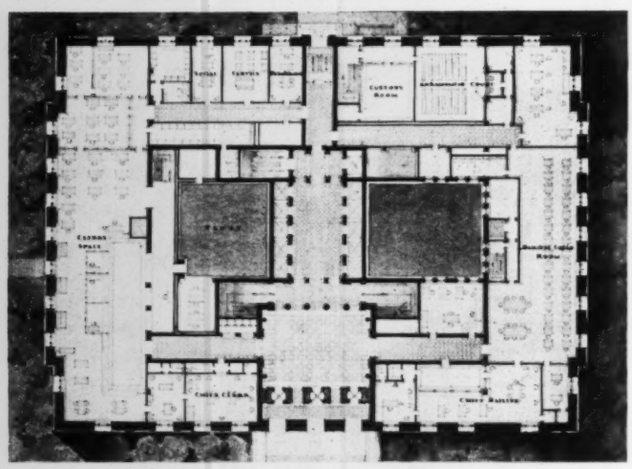
Combination Steam and Hot Water Systems Heat Court House and Jail

By H. A. Durr*

ON ONE of the boulevards in the southwest section of Chicago a group of buildings has recently been erected under the direction of the Cook County Commissioners of the State of Illinois to be used as jails, a court house and an administration building. The group consists of six buildings, the largest of which is the Criminal Court House.

The court house is a seven-story and basement structure facing east, containing the various court rooms, judges' chambers, record vaults and offices for the state's attorney, bailiffs and clerks. An attic pipe space has been provided above the seventh story wherein the overhead piping for the various services is run. A pump room has been provided in the northwest corner of the basement to and from which all pipe services for the building are run.

The administration building is a five story and base-



FIRST FLOOR PLAN OF THE CRIMINAL COURT HOUSE

ment structure immediately to the rear of the court house and provides facilities for housing the jail administration employes and the jurors. This structure is accordingly a combination hotel, office building and jail. A kitchen is installed on the second floor of this building of sufficient size to care for all jurors. An attic pipe space above the fifth story contains the miscellaneous piping services.

The Cell Buildings

The four cell buildings are practically all alike in size and shape and appear in numerical order immediately to the rear of the administration building. In all there are 1,302 individual cells.

Cell Building No. 1 is a four-story and basement structure with a fifth story over the center portion of the building. A kitchen for the jail is located in the south wing of the basement of this unit, and a hospital for the prisoners occupies the fourth floor. The remainder of the building is devoted to individual cells.

Cell Building No. 2 is similar to No. 1, excepting that the main pump room for the entire building group occupies the south wing of the basement. The remainder of the building is devoted to individual cells.

Cell Building No. 3 is a four-story and basement structure similar to Buildings Nos. 1 and 2, but not having the fifth story portion above. The south wing of the basement contains a laundry, while the remainder of the building is devoted to cells.

Cell Building No. 4 is similar to Building No. 3 and is entirely devoted to individual cells, with the exception that means have been provided in the basement of this unit for the installation of an electric chair.

A tunnel, connecting all buildings of the group, extends westward from the center of the court house through the center of the remainder of the buildings. This tunnel bears the same relation to the buildings that a telegraph pole does to the branch arms. All main piping is run on the ceiling of this tunnel, where it is readily accessible for repairs at all times. Provision has been made at this time in the piping systems for the building of three more cell buildings west of the existing group.

The Heating Systems

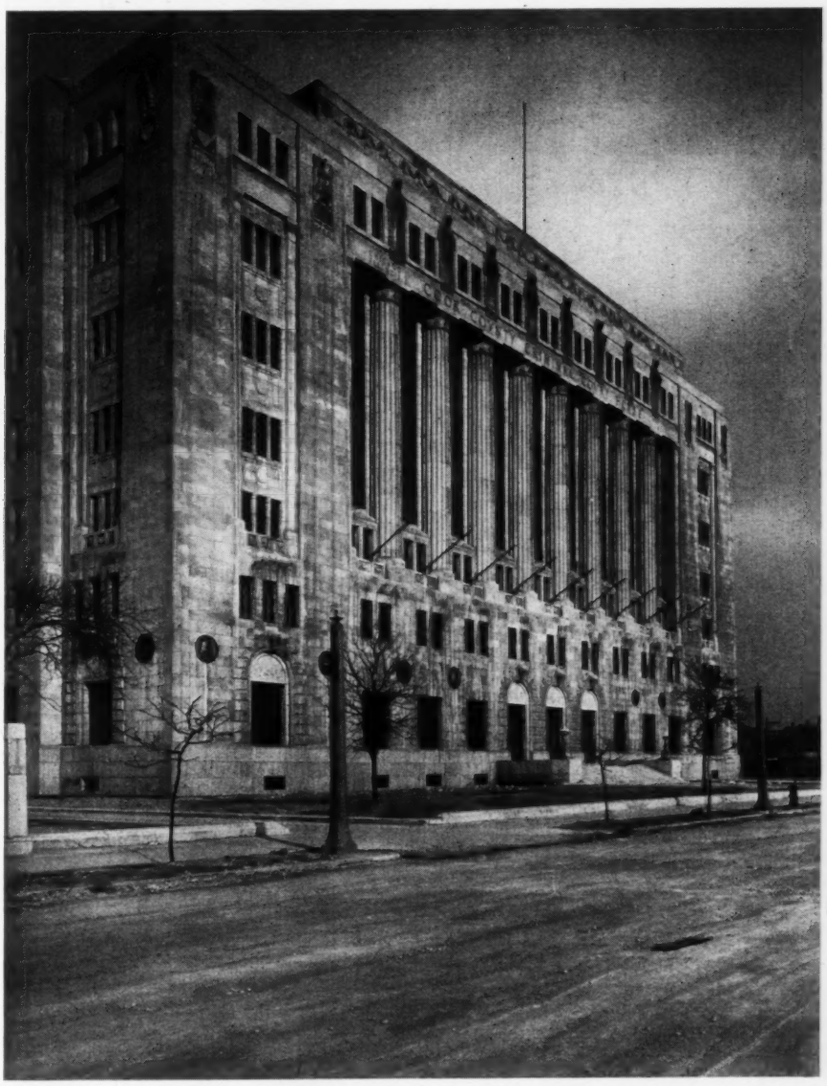
Housing facilities and health requirements of prisoners are becoming more of a problem every day. This is particularly true in the Cook County jail, where prisoners for the most part are lodged awaiting trial or sentence. The prisoners naturally expect confinement, but they should not be exposed to disease, foul air or insufficient light and sunshine.

After a thorough consideration of all requirements and a study of existing institutions in various sections of this country and Europe, it was decided to heat the jail buildings and administration building by means of hot water, while the Criminal court is heated by low pressure steam. In the court house building, where steam is used in the radiators, temperature control devices have been provided with thermostats on the walls of the rooms and air pipe connections are run from them to the radiator valves. In the four jail units and the administration building a problem presented itself because of the prisoners. These men and women, with but little to do while awaiting trial, often times try to content themselves by taking anything apart which they can lay their hands on. It was therefore thought best to employ a forced system of hot water circulation with no control devices *in the buildings heated*. The temperature of the water

* H. A. Durr & Company, consulting engineers, Chicago.

IT WAS NECESSARY TO USE TWO HEATING SYSTEMS—STEAM AND HOT WATER—IN THIS NEW JAIL AND COURT HOUSE GROUP. YOU'LL FIND ITS DESCRIPTION INTERESTING.

THE METHOD OF VENTILATING THE LARGE RECORD VAULT—ALWAYS A DIFFICULT PROBLEM—SHOULD BE APPLICABLE TO BANKS AND PUBLIC BUILDING VAULTS.



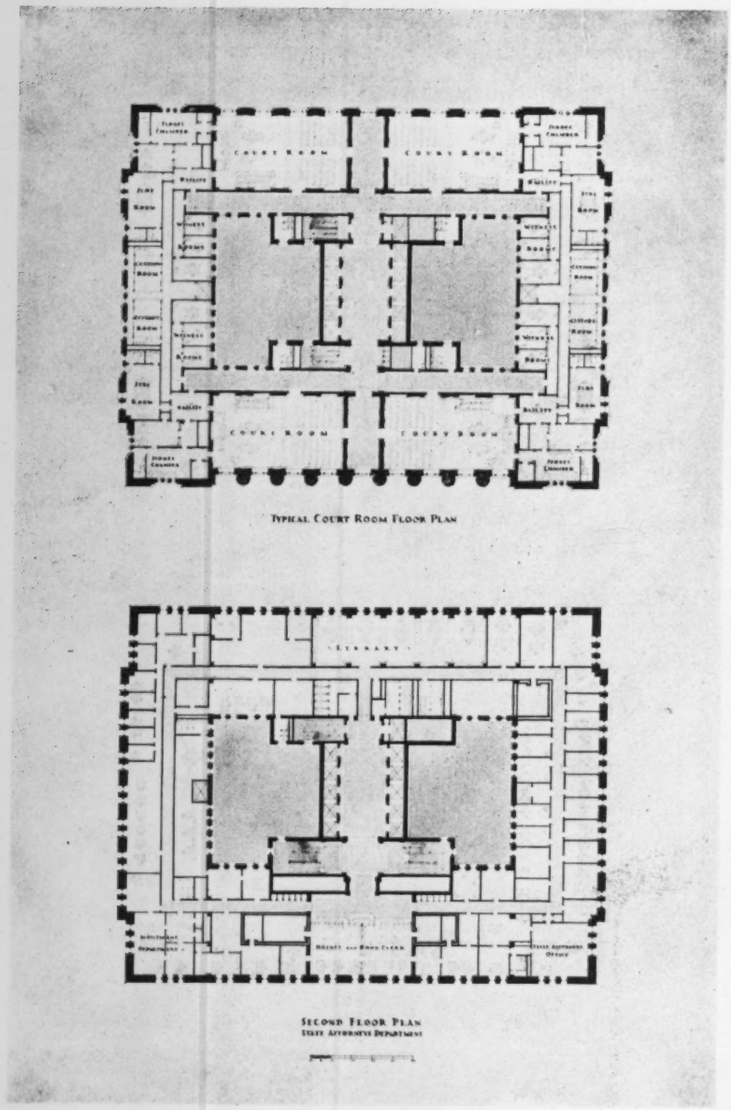
THE NEW COOK COUNTY CRIMINAL COURT HOUSE, LOCATED IN THE SOUTHWEST SECTION OF CHICAGO

is controlled at one point, namely, in the basement pump room at the hot water heaters, where the water temperature is varied to suit the outside weather conditions.

Steam Purchased from Municipal Plant

The municipal jail of the city of Chicago (the Bridewell) occupies a site directly south of the Cook County site. The Bridewell power house was originally equipped to care for future expansion, which did not develop to any great degree. Consequently a source of steam for power and heating purposes was available at a low rate and it was decided to purchase steam from the municipal power house, instead of erecting a new power house on the county site. The steam services from the Bridewell power house consist of an 18-in. low pressure line (3 lb. pressure) and an 8-in. high pressure (150 lb.) line. Both lines are metered and dripped at the point of entrance to the main pump room in Cell Building No. 2.

The 8-in. line high pressure is reduced through a series of bypassed pressure reducing valves to the various pressures required in different portions of the building group; 150-lb. steam is taken off ahead of the pressure reducing valves in two 4-in. lines, one serving the hot water circulating turbines and pumps in the pump room of Cell Building No. 2, and the other running direct to the steam driven reciprocating pumps in the court house basement. Intermediate pressure steam is provided through pressure reducing valves at 90 lb. for the laundry equipment, at 60 lb. for the kitchens and various sterilizing equipment and at 2 lb. for makeup steam for heating purposes. The 60-lb. steam was further reduced to 25 lb. pressure at the kitchen equipment. All equipment, where practical, was installed in duplicate, half being steam driven and the other half motor driven to



insure continuity of service as far as possible in the event of failure of either of the services, and also to provide efficient operation in both summer and winter.

Heat Converters

The 18-in. low pressure service was brought direct to two heat converters and split into two 12-in. branches each of which feeds one of the converters. The converters are used to heat water for the hot water heating system, and each has a heating surface built up of approximately 1,035 sq. ft. of ¾-in. seamless drawn U-shaped copper tubing. Each heater is provided with an 8-in. inlet and an 8-in. outlet connection for the water, a 12-in. steam inlet and a 5-in. drain connection. The water flows through the copper tubing, which is completely surrounded by steam, and passes out at the top of the heater. Each heater is approximately 214 in. long and 24 in. in diameter and is provided with both water relief and air valves. The drain connections from each converter feed into an 8-in. header, which drops into a trench below the pump room floor and rises into the vacuum pump header at the opposite side of the room. Each of these two pumps is steam driven and discharges condensate directly back to the Bridewell power house.

The 2-lb. steam available from the 8-in., 150 lb. line after passing through the pressure reducing system is connected into a 14-in. line which serves the steam heating system in the court house building.

All exhaust steam from turbines, pumps and engines, in the pump rooms, is returned into the low pressure line.

A duplex condensation returns pump is provided at the lowest point in Cell House No. 2. The returns from the various services drain back to this tank by gravity and collect into one header draining into the tank. The pumps are float operated and discharge through a 4-in. line. At the point of entrance to the tunnel leading back to the Bridewell all condensation return lines are collected into one line which carries back 1,900 feet to the Bridewell power house.

Hot Water Heating System

The administration building and each of the four cell buildings are heated by separate overhead hot water mains, each of which is served by a valved riser connecting to a main trunk line in the basement pipe tunnel. The 8-in. outlets from each of the two hot water converters are connected into a 10-in. header, which runs from the pump room in Cell Building No. 2 to the tunnel and there distributes to each of the five buildings served. Each of the cell buildings is served through a 3½-in. main riser, while the administration building is served through a 4½-in. riser.

The distributing main for the administration building is run in the attic space above the fifth floor, while that in each of the cell buildings is run on the fourth floor ceiling. The mains distribute through downfeed risers, each radiator being provided with a top supply and bottom return connection. The returns from the radiators are collected into separate return mains on the basement ceiling of each building, which are in turn collected into a 10-in. main return line, running back to the hot water circulating pumps in the pump room in Cell Building No. 2.

Each of these two pumps is designed to pump 1,200 g.p.m. at 185 F on a closed circuit with pressure on the suction against a net friction head loss of fifty feet. One of these pumps is turbine driven and the other has an electric motor drive, each running at approximately 1,750 r.p.m.

An expansion tank is placed at the high point of the system in the administration building and is provided with a drain valve and an overflow. From the under side of the expansion tank a 2½-in. make-up line was run directly back to the suction header of the circulating pumps.

Thermometers are placed on each branch from the main supply and return lines in the tunnel; with each thermometer a cut-off valve is installed. Each radiator is provided with a radiator valve on the return side of the radiator only. This combination permits a very fine degree of control. The valves on the mains were set when the system was first adjusted and this adjustment

has proved to be final and permanent. Individual control is obtained by operating the hand valve on the return end of each radiator. Automatic air traps are provided at all high points in the system and each radiator is provided with a standard key operated air valve.

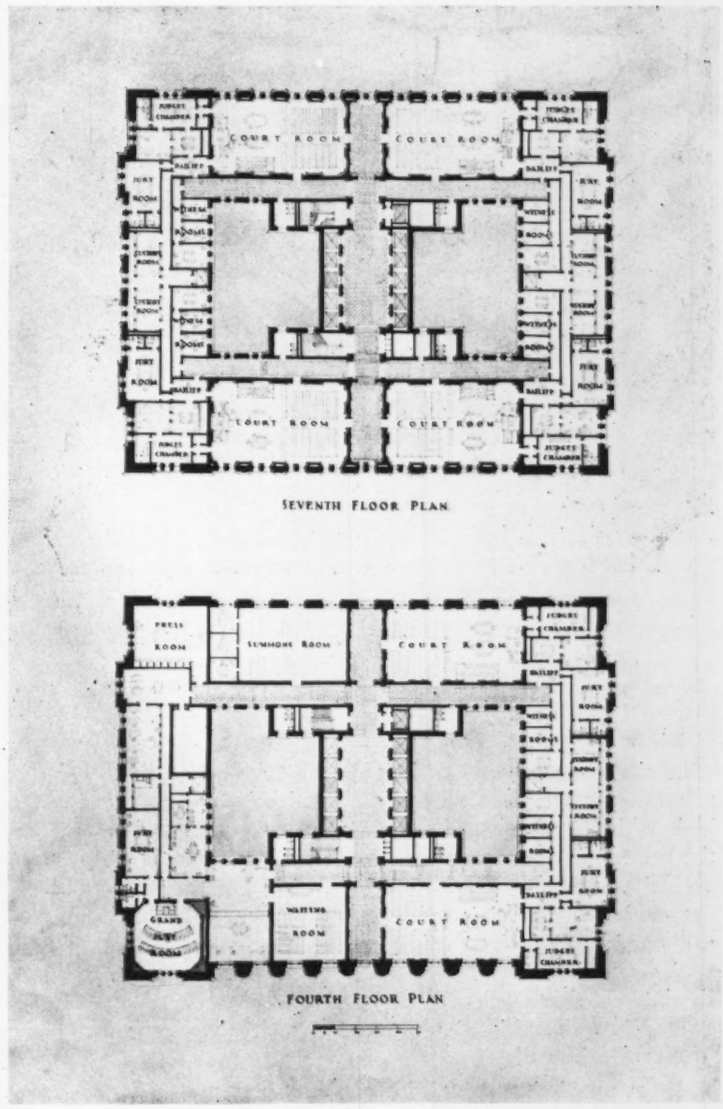
Feeding Radiators Above Overhead Main

It is interesting to note the method of feeding radiators in the buildings which are at a higher level than the overhead main. These radiators are merely in parallel with the main, both supply and return connections being made to the main. The radiator thus serves as an enlargement to the main hot water line and a portion of the water circulates through it.

Steam Heating System

The 14-in. low pressure steam line to the Criminal Court building reduces to a 10-in. line, which rises vertically to the attic space above the seventh floor and there splits into two branch mains each serving one-half of the building. The radiators on each floor are served through downfeed risers and the returns are collected into return mains on the basement ceiling. The return mains run back to vacuum pumps in the basement pump room, which discharge into a return line running back through the tunnel to the Bridewell power house. The vacuum pumps are steam driven, designed for 150 lb. pressure.

In the summer the only load in the court house is for domestic hot water. For this purpose a motor-driven return pump and receiver of 3,000 lb. per hour capacity has been installed, discharging into the return line from the vacuum pumps. Every precaution has been taken to insure dry steam and numerous drip lines at various points of the system carry the condensate back to the vacuum pump header.



The steam radiators in all of the court rooms and other main rooms, where a group of people might be assembled, are thermostatically controlled. An air compressor in the court house basement, together with a system of air piping carried throughout the building, serves all thermostatic valves and give a degree of temperature control equal to that obtained on the hot water heating system in the remainder of the buildings.

All of the risers are individually valved and tagged, so that trouble at one point of the system would not necessitate the shutting down of more than one riser.

Ventilation

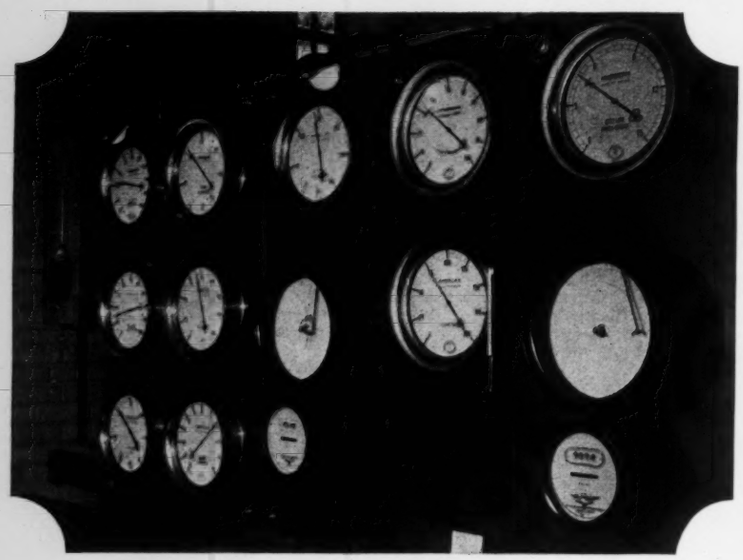
Ventilating equipment was provided in each of the buildings and for the most part it was mechanical, excepting in the jail units, where natural ventilation was employed. Provision, however, was made for exhausting large volumes of air through roof ventilating heads on the roof above each tier of cells in the jail buildings.

The ventilating system in the court house consists of two fresh air units, each having four stacks of heat surface split up into two sections of preheater and two sections of reheater. Two 8-in. steam lines from the base of the main heating riser, where it reduces from 14 in. to 10 in., serve the heating surface, one being run to each of the two groups.

Ventilating the Vault

The method of properly ventilating a large vault was one of the problems presenting itself. This problem has confronted engineers on bank buildings and public buildings having vaults for many years, but insufficient study has usually been given to it. Due to the extremely high value of the contents of a vault, and the fact that many times it is utterly impossible to replace certain papers and other valuables, the first and most important thought has always been to make the vault absolutely fireproof as well as burglar proof. For this reason ventilating ducts, conduits or any other possible paths for a fire or an explosive mixture have always been kept outside of the vault.

The ventilation of the vault has either been entirely neglected, if the vault was infrequently occupied, or several electric fans were placed within the vault to stir up the air. A step farther in the right direction was made when engineers placed an exhaust register at the ceiling immediately outside of the vault door, and attempted to create circulation to the register by means of fans placed within the vault. These methods served



GAGES THROUGHOUT THE SYSTEM KEEP AND OFFER A RECORD OF PERFORMANCE EVERY MINUTE OF THE DAY. THESE ARE MOUNTED ON A BOARD IN THE PUMP ROOM

their purpose when the vault was infrequently occupied or when the occupancy was of a transient nature.

In the Cook County Criminal Court building there are two large record vaults, one of which is two stories high with a stairway to the upper story placed inside the vault. The enormous amount of business transacted necessitates the continuous working of many people in the vaults during the entire day. The problem here presented was entirely different from that of most vaults and included the removal of the musty odor, the introduction of a constant supply of fresh air, the removal of the vitiated air and the entire elimination of the fire hazard.

A system of sheet metal ducts with numerous register faces was installed inside of each vault and the supply end at which the fresh air was to enter terminated in a small plenum chamber which was provided with an air-tight door on the vault side and a steel vault door on the corridor side. This opening had been provided in the vault wall primarily as an emergency exit and could not be permanently obstructed in any way. Just outside of this door, at the corridor ceiling, a collar was provided connected to a large fresh air system, which served the east portion of the building.

A sheet metal circular duct connection with an adjustable screw collar at the intake end and a rectangular opening at the discharge end was installed suspended from a track fastened to the corridor ceiling. The vault end of this connection was made the same size as the emergency vault door and is provided with a felt strip to insure a tight connection.

When it is desired to ventilate the vault the emergency vault door is opened; the sheet metal connection is moved into place on the track and the adjustable collar is firmly turned up against the collar on the main duct system, thereby making a rigid connection and completing the air circuit. The fresh air is then forced through this system when the damper is opened.

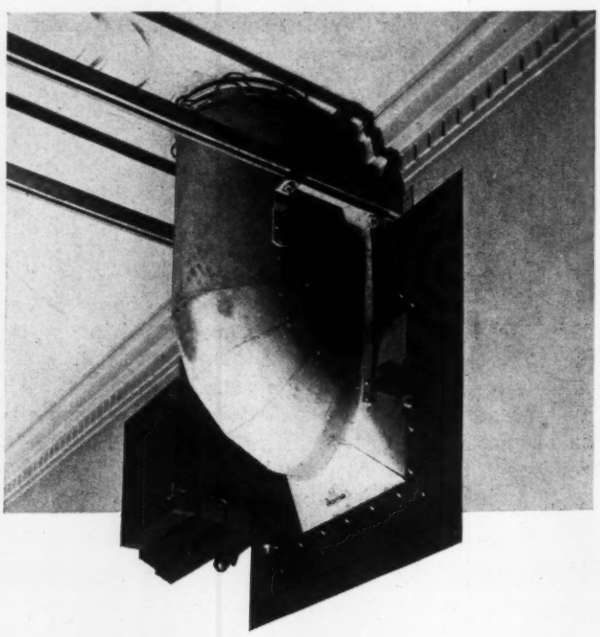
A large register connected to the exhaust ventilating system was placed in the corridor ceiling just outside of the main vault entrance.

The fresh air is forced into the vault at the wall lines farthest away from the entrance, from which points the air passes over the entire area of the vault toward the main door. The vitiated air travels through the main vault door and rises up into the ceiling exhaust register immediately in front of this door. The circuit is complete and positive.

Gages Aid Control

Gages throughout the system keep and offer a record of performance every minute of the day. These gages have all been mounted on one board and permit the engineer to have accurate knowledge of what is happening at various points in his heating systems.

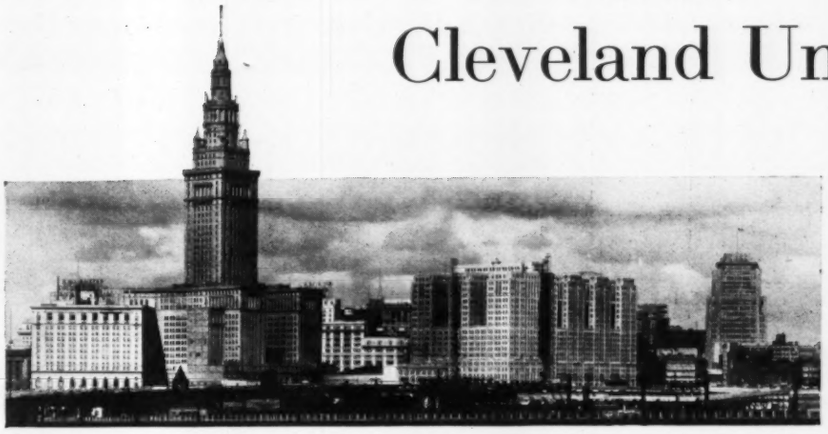
The installation presents many phases of interest and comprises a total of approximately 40,000 sq. ft. of equivalent steam radiation and 55,000 sq. ft. of hot water radiation, with provisions throughout the hot water system for the addition of 35,000 sq. ft. of hot water radiation for three more cell buildings.



IN ORDER TO MAKE THE CLERK'S RECORD VAULT ABSOLUTELY FIRE- AND BURGLAR-PROOF, THE SECTION OF VENTILATING DUCT IS MOVED BACK ON THE TRACKS ON THE CEILING AT NIGHT, AND THE HEAVY DOOR IS CLOSED

Sheet metal contractors who make a specialty of welding ducts for ventilating and warm air systems often build this equipment in sections in their own shops of 12 to 16-gage sheet or whatever thickness is specified and the units may be shipped to the final destination, erected and welded into a continuous system. In this way the more complicated fittings and joints may be fabricated in the contractor's own shop and the number of position welds reduced.

Heating and Air Conditioning the Cleveland Union Terminal



By J. W. Carrow*

LAST month, J. W. Carrow described the heating systems in the magnificent new Cleveland Terminal and referred briefly to the air conditioning. In this article he describes the ventilation of the entire building and the complete air conditioning systems for the dining room, the lunchroom, and the barber shop.

General service refrigeration is also discussed; the air conditioned display cases in the candy shop, the food shop and the drug store concession spaces are considered, too.

Ventilation

Mechanical ventilation, one of the most exacting of the requirements in the almost complete absence of outside exposure, is provided for all spaces throughout the entire building. The demands for ventilation are met by complete supply and exhaust systems for all spaces and arranged into two classes of services—namely, the station building and concession spaces.

The installation consists of 61 fans with a total capacity of 1,626,100 c.f.m. These units are in groups in various parts of the building, their locations being those best suited for the spaces they serve with inlets and outlets in the roofs of the station building and air-rights buildings.

The largest individual fan has a capacity of 85,150 c.f.m and the smallest 250 c.f.m. Space has been provided for 4 future fans and duct work, making the ultimate installation 65 units with a total capacity of 1,823,500 c.f.m.

The fans are all direct connected to 220 v. d-c motors except for the cab stand and joint drive fans, which are belt-driven. All fresh air delivered by the fans is filtered through self-cleaning air filters and is tempered and reheated by passing it through heaters, with thermostatic control of both the steam supply and mixing dampers.

The duct work was exceedingly complicated because of the limited space available for the installation; in certain portions of the building there were no locations available except in furred spaces and furred ceilings. The largest duct measures 17 ft. wide by 26 in. deep.

All spaces are provided with air supply and exhaust except the cab stand and joint drive; here it is entirely a problem of removing the exhaust gases from the motor-vehicle engines. Ventilation here is confined to exhausting air. The space being unheated, fresh air is taken from the track space below through grilles at the columns and outside walls at the floor supplemented by air through the drive entrance. Exhausting of air is done at the ceiling.

Fresh air is introduced in the east and west traction concourses through high wall grilles in the east and west walls and at the stair landings. The ticket lobby has its fresh air supply through grilles at four faces of the twelve columns in the center of lobby and high wall grilles at the north end. At each pier on the east and west sides of the steam concourse are fresh air grilles near the floor for air supply and in the balustrades at the head of the stairs and at the stair landings. Air is introduced through these grilles at a low velocity.

The waiting room air supply is at the ceiling downward through small grilles over the entire area exhausting near the floor at the east and west walls. Generally, fresh air supply and exhaust for other spaces is through grilles in the furred ceilings, at low velocities.

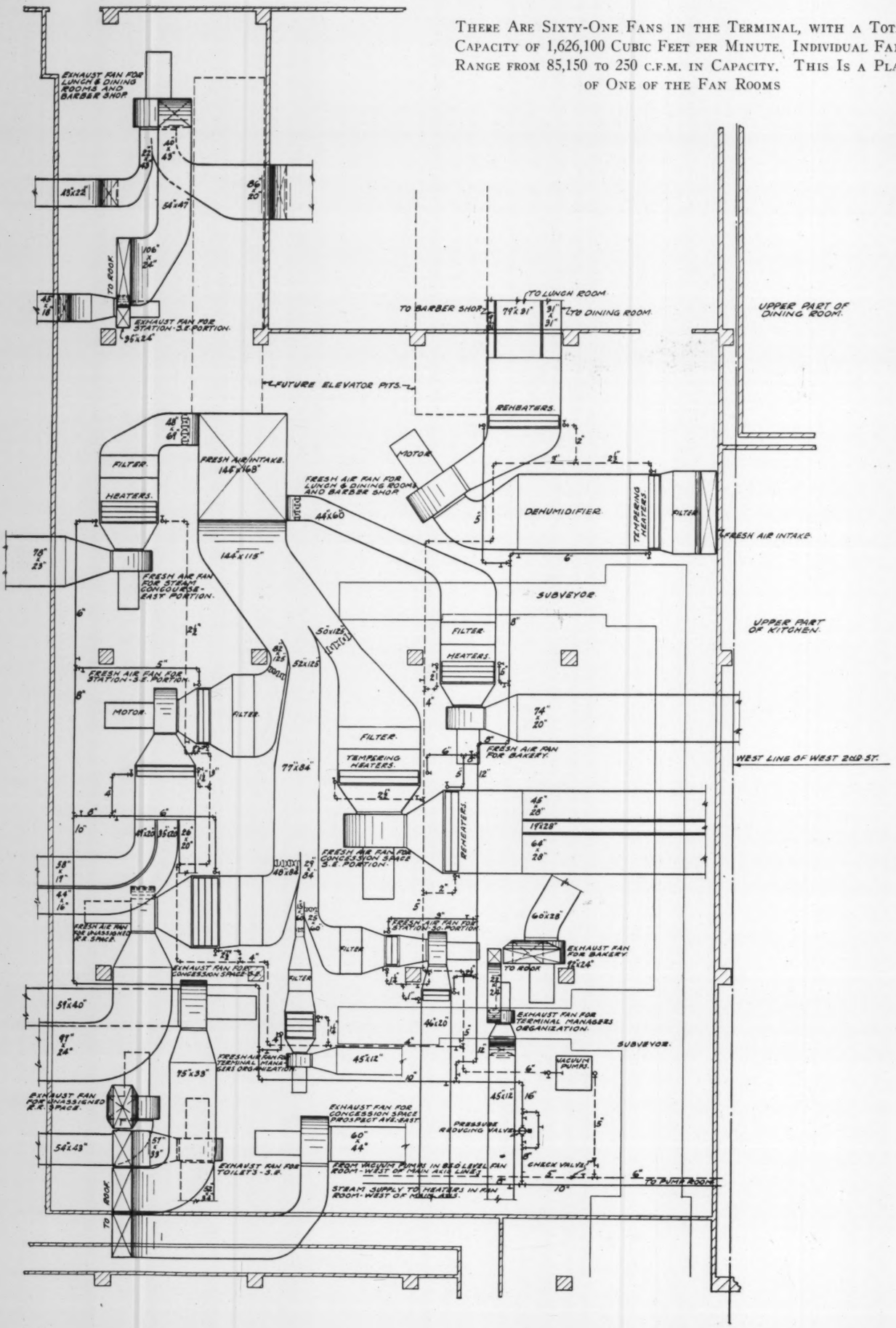
The Air Changes

Air changes per hour were calculated as follows:

Space	Supply	Exhaust
Steam Concourse	6	..
East Traction Concourse	6	4
West Traction Concourse	6	4
Waiting Room	8	8
Ticket Lobby	6	4
Ticket Sellers	10	10
Baggage Room	6	6
Mail and Express Facilities	6	6
Joint Drive	See Note	5,000 c.f.m. Per Truck
Cab Stand	See Note	5,000 c.f.m. Per Truck
Shops	10	10

* Mechanical department, Graham, Anderson, Probst, and White, architects, Chicago.

THERE ARE SIXTY-ONE FANS IN THE TERMINAL, WITH A TOTAL CAPACITY OF 1,626,100 CUBIC FEET PER MINUTE. INDIVIDUAL FANS RANGE FROM 85,150 TO 250 C.F.M. IN CAPACITY. THIS IS A PLAN OF ONE OF THE FAN ROOMS


EXHAUST FAN FOR LUNCH & DINING ROOMS AND BARBER SHOP
TO ROOF
EXHAUST FAN FOR STATION-S.E. PORTION.
TO BARBER SHOP
TO LUNCH ROOM
TO DINING ROOM
UPPER PART OF DINING ROOM
FUTURE ELEVATOR PITS
REHEATERS
FILTER
HEATERS
FRESH AIR INTAKE
FRESH AIR FAN FOR LUNCH & DINING ROOMS AND BARBER SHOP
MOTOR
DEHUMIDIFIER
TEMPERING HEATERS
FRESH AIR INTAKE
FRESH AIR FAN FOR STEAM CONCOURSE-EAST PORTION.
SUBVEYOR
UPPER PART OF KITCHEN
FRESH AIR FAN FOR STATION-S.E. PORTION
TEMPERING HEATERS
FRESH AIR FAN FOR BAKERY
WEST LINE OF WEST 2ND ST.
FRESH AIR FAN FOR CONCESSION SPACE S.E. PORTION
FRESH AIR FAN FOR UNASSIGNED R.R. SPACE
EXHAUST FAN FOR CONCESSION SPACE S.E.
FRESH AIR FAN FOR STATION-S.W. PORTION
EXHAUST FAN FOR BAKERY
EXHAUST FAN FOR TERMINAL MANAGERS ORGANIZATION
FRESH AIR FAN FOR TERMINAL MANAGERS ORGANIZATION
VACUUM PUMP
EXHAUST FAN FOR UNASSIGNED R.R. SPACE
EXHAUST FAN FOR CONCESSION SPACE PROSPECT AVE. EAST
PRESSURE REDUCING VALVE
CHECK VALVE
EXHAUST FAN FOR TOILETS-S.E.
FROM VACUUM PUMPS IN BSMT. LEVEL FAN ROOM-WEST OF MAIN AXIS LINE
TO PUMP ROOM
STEAM SUPPLY TO HEATERS IN FAN ROOM-WEST OF MAIN AXIS

Bake Shop	20	20
Kitchen	20	30
Dairy Department	20	20
Toilets (main)	15	30
Toilets (small)	..	30
Barber Shop	10	10
Dining Room	12	12
Lunch Room	12	12
Pump Room	10	10
Other Station Facilities	6	6

Note: Fresh air supply for the cab stand and joint drive is from the track level supplemented by air through drive entrances.

Spray Cools Intakes

Fresh air intakes for a part of the installation are located well above the street in the roofs of air rights buildings, while some are installed in the station roof at the street level; these are temporary until such a time when other air rights buildings will be constructed; they will then be extended to the roofs of the new buildings. To prevent heat from being carried into the fresh air supply, a canopy of wood frame construction was erected and covered with ¼-in. corrugated asbestos roofing, above the intakes with an overhang of 10 feet. Six feet in front of the intakes, on all sides, is a baffle 6 feet high, of the same material. A spray of cold water was added to the roofs through a ¾-in. pipe. This construction was selected to reduce the temperature of the fresh air supply during hot summer months. A considerable drop in temperature of the air supply is noticeable.

Duct Work

Exhaust ducts carrying acid fumes from battery-charging rooms are made of special corrosion resisting metal. Kitchen exhaust ducts subject to fire and discharge from fans are of number 14 gage black iron. All other duct work is galvanized iron of the following gages:

24 in. and less in width or depth—No. 24 U. S. gage.
25 in. to 36 in. in width or depth—No. 22 U. S. gage.
37 in. to 60 in. in width or depth—No. 20 U. S. gage.
61 in. and above in width or depth—No. 18 U. S. gage.

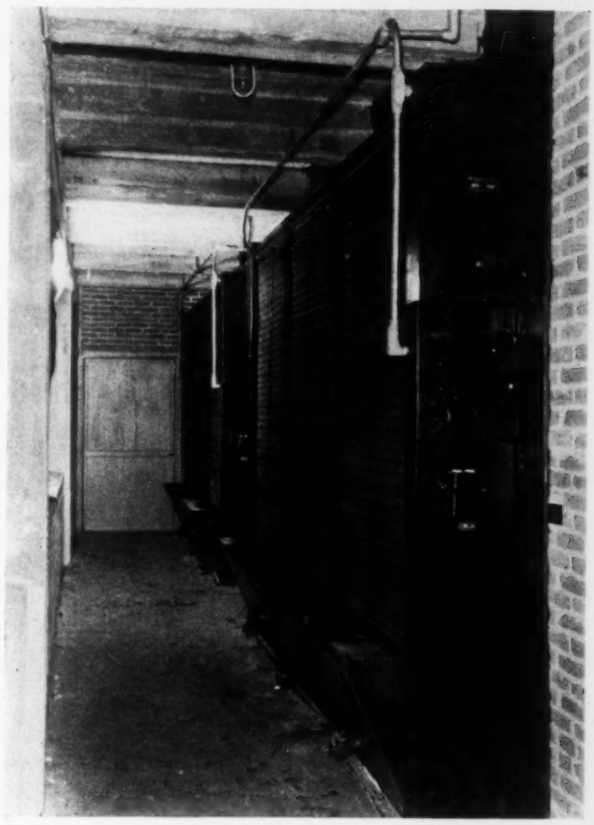
Fan chambers are number 14 gage and fresh air intakes number 18 gage. All duct work is painted two coats of lead and oil. Eight hundred tons of metal were used for this installation.

Expansion Joints in Ducts

At points where the ducts cross street expansion joints, an expansion joint was installed in each duct 12 inches long made of heavy canvas fastened rigidly to angles and riveted securely to the duct, providing for a movement of the duct with the expansion of the street. The kitchen exhaust fan discharge duct is constructed with welded joints for its entire length to prevent the escape of any odors to the building. Volume and mixing dampers are installed in each fresh air supply line from the fan chamber. At every junction of a fresh air and exhaust duct to a main, air splits and deflectors are installed. Each supply inlet has difusers arranged to distribute the air equally over the entire area of the grille. The fresh air intakes have hand operated louvre dampers.

Fresh Air Supply System

All fresh air supplied to the various rooms is heated by four stacks of heaters installed in groups of two stacks each (tempering and reheating) or in one group of four heaters, the arrangement depending on whether air at different temperatures is desired from a single fan unit. A hand control shut-off valve is located in the



THE AIR SUPPLY IS FILTERED THROUGH SELF-CLEANING FILTERS. AIR FOR THE DINING ROOM, LUNCH ROOM AND BARBER SHOP IS ALSO DEHUMIDIFIED IN THE SUMMER

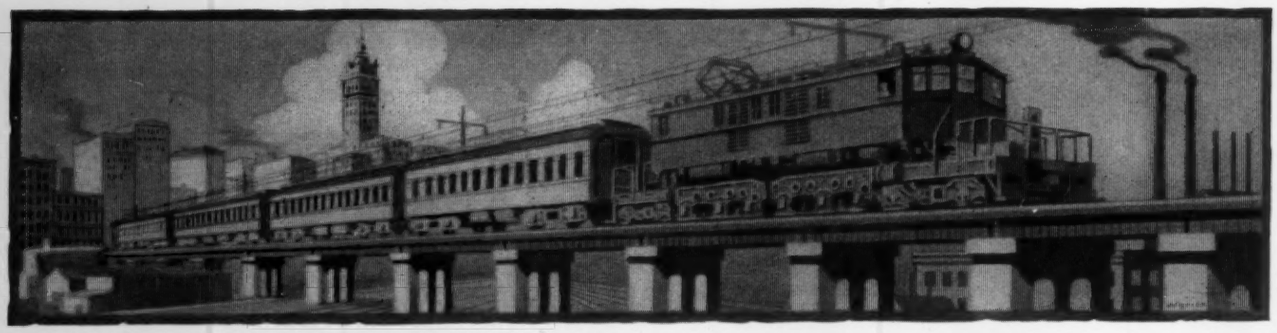
steam supply for each stack of heaters nearest the intake, the other three stacks having thermostatic control. The temperature of the entering air varies from 70 to 85 F, depending on the room and outside temperatures. The air supply is filtered through self-cleaning filters, and in addition the supply fan unit for the lunch, dining rooms and barber shop air cooling is provided with a dehumidifier.

Exhaust Systems

In the discharge duct from each exhaust fan are self-closing aluminum louvres except for the kitchen exhaust fans which have stationary louvres with a hand operated damper in the suction duct near the fan. Each kitchen exhaust fan has a by-pass duct around the fan in which is located a fusible link damper which closes in case of fire. Odors from the kitchen and battery room fans are discharged through the roof of the Midland Bank Building 200 feet above the street level.

The Fans

Fans were required which would (under the great variety of operating and space conditions) be practically noiseless in operation, fit into the limited spaces, efficiently handle the amounts of air required and at the same time be well constructed and guaranteed to meet the operating conditions. All fans are erected on anti-vibration foundations, this being essential for noiseless



operation, as they are located on framed floors and many are adjacent to public spaces.

Fans are direct-connected to motors except in the cab stand and joint drive units, which are belt driven. Exhaust fans for the cab stand and joint drive are double width with double inlets and full housed; all other units are single width, single inlet, and full housed. A canvas duct connection 6 inches long, having an iron frame at each end and fastened securely to the main outlet of each fresh air fan and the main inlet of each exhaust fan, was installed to prevent any noise or vibration from being transmitted to any part of the building.

Motors

Fan motors are interpole, shunt wound, variable speed type using direct current at 220 volts. Horsepowers are based on a fan efficiency of 50 per cent and made to operate over a speed range between 70 per cent and 125 per cent of normal speed for all fresh air and toilet exhaust fans and 55 per cent to 110 per cent of normal speed for all other exhaust equipment. Belt drive motors have sliding bases.

Grilles

Grilles in marble walls and wood panels are of cast bronze, special design, having 50 per cent to 60 per cent free areas and in plaster ceilings and walls they are stamped steel with 65 per cent free openings. A damper with a locking device for air control is installed back of each grille and close to the face. All grilles except bronze are painted to match the adjacent finish.

All fresh air inlets at the floor have a velocity of 100 f.p.m., in ceiling 125 to 175 f.p.m., and in the walls near the ceiling 300 to 450 f.p.m., depending on the height of the grille above the floor. Exhaust openings at the floor are based on a velocity of 200 f.p.m. and at the ceiling, 350 f.p.m. was established.

Air exhausting through openings in kitchen exhaust hoods has a velocity of 500 f.p.m. Duct work at the cab stand and joint drive ceiling is exposed, each opening being provided with a screen and having a velocity of 400 f.p.m.

Temperature Regulation

Automatic temperature regulation is installed for domestic water heaters, hot water heating converters, and fan tempering heaters (except the first section, which has a hand control shut-off valve) fan reheaters and fan dampers. Each duct from a fresh air fan chamber has a thermostat for controlling mixing dampers so that room temperatures of 60 or 70 F as desired can be maintained.

Dining, Lunch Room and Barber Shop Air Conditioned

Comfort was one of the services that was uppermost in the minds of the owners, and since the temperature and moisture condition of the surrounding atmosphere largely determines personal comfort, provision was made to control these factors in the dining room, lunch room, and barber shop.

Experience has shown that, unless special precautions are taken, dining rooms during the hot summer days are the most uncomfortable of all public places. This is because, in addition to the heat liberation ordinarily encountered, a considerable amount of heat and moisture is given off by the foods being served. That conditions may be enjoyable to the greatest extent, air conditioning equipment was installed to control both temperature and humidity, maintaining comfortable conditions the year around.

A conditioning system was installed with separate supply lines to each of the three rooms, so that the temperature in each can be maintained as desired. The system consists of a supply and exhaust fan, dehumidifier with cooling coils, pumps, filter, and central refrigerating plant. Fans, dehumidifier and water circulating pumps are located in the 85.0 level fan room east of the main axis almost directly above the lunch room, while the cooling plant (together with the brine circulating pumps) is in the refrigeration plant room at the 72.5 level adjacent and east of the joint drive.

The conditioning equipment has been designed with sufficient capacity to maintain an inside temperature of 75 degrees and a relative humidity of 55 per cent when the outside temperature is 85 degrees dry bulb and 73 degrees wet bulb. To accomplish this, means had to be provided to remove all of the heat liberated in the conditioned rooms from such sources as electric lights, the food, the patrons and also that transmitted through the walls from the outside or neighboring unconditioned rooms. In addition to removing sensible heat a considerable amount of moisture had to be taken out of the air to maintain the best comfort conditions, and this required additional cooling capacity.

To remove this heat one 75-ton absorption refrigerating unit was installed. Ammonia is used as the refrigerant, cooling brine which is pumped to the coils in the dehumidifier by two centrifugal pumps, capacity 400 g.p.m. at a discharge pressure of 30 lb., direct connected to two 15 hp. constant speed d-c 230 v. 1,800 r.p.m. motors, at a temperature of 20 to 25 F. Each pump has a capacity large enough for the service.

Brine circulation to the coils is through 6-in. supply and return lines.

The dehumidifier is 15 ft. long, 10 ft. wide and 9 ft. high, the floor space and clear head room limiting these dimensions. Brine coils are 1¼ in. in diameter and occupy the center portion of the dehumidifier for a distance of 8 ft. by 10 ft. wide and 7 ft. high, water being sprayed over the coils by a centrifugal pump, capacity 250 g.p.m., at a 30-ft. head, direct connected to a 3 hp. 230 v. 1,750 r.p.m. constant speed d-c motor. Another centrifugal pump and motor of the same capacity and speed (but operating at a 70 ft. head and with a 7½ hp. motor) furnishes the water supply for the flooding and spraying nozzles. Cooling is effected by spraying of water over the brine coils.

A total of 38,325 c.f.m. is cooled and delivered to the dining room, lunch room, and barber shop, 7,875, 25,050, and 2,400 c.f.m., respectively, through the separate duct lines. The air supply to the dehumidifier is partly filtered fresh air passing through self-cleaning filters, and the balance of the air is recirculated.

Thermostat-controlled dampers are arranged so that as high as 60 per cent, or 23,000 c.f.m., can be recirculated as required by outside conditions, the exhaust fan discharging to the atmosphere that portion not returned through the recirculating duct to the dehumidifier. All dampers are actuated by gradual-acting thermostats.

Control valves are installed in the brine supply line and the by-pass at the dehumidifier, and are controlled by a gradual-acting thermostat located between the dehumidifier and fan in the spray chamber and set to maintain approximately 50 F in the dehumidifier. The control of the amount of air through the recirculating ducts and from the outside is by thermostats located in the discharge chamber of the unit.

Air Supply to Dining Room

Air is supplied to the dining room through grilles on the west, north, and east walls at the ceiling, 19 feet above the floor and exhausted at the floor at the same sides of the room and also at the ceiling at the south end. The exhaust air is slightly less in volume than the air supply; this was done so that there would be a slight pressure in the room, giving a natural flow of air outward rather than inward, the excess in supply being taken by the exhaust system in the kitchen. Air supply to this room is 10,625 c.f.m. and the exhaust is 7,725 c.f.m. This room has a seating capacity of 268 people.

The Lunch Room

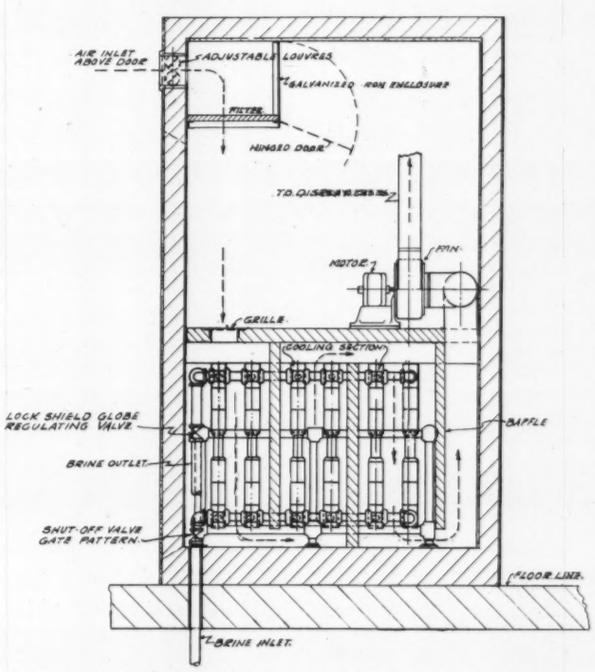
The air supply for the lunch room is at the ceiling, 7 ft. 9 in. above the floor along the north, west, and south walls, exhausting at the floor in the north and south walls and at the ceiling at the east end of the lunch counters. The exhaust for this room is 18,825 c.f.m., or less than the air supply of 24,550 c.f.m. This room is also under pressure. Counter and table service in this room provides for 634 people.

Conditioned Air For the Barber Shop

The barber shop having a low ceiling, air is introduced through the grilles in coffered ceiling in the center portion of the room discharging horizontally and exhausting through registers in the ceiling located close to the walls. Architectural treatment would not permit the installation of grilles in the side walls of this room. An air supply of 2400 c.f.m. and exhaust of the same quantity was used for this room. Air quantities for these rooms were not based on any arbitrary air-change factor, but were based on the temperature rise desired between the inlet air and required room temperature.

Cool Air for Display Cases

In addition to air conditioning for the above rooms, cool air is supplied to display cases in the food shop, candy shop, and drug store concession spaces; 400, 250 and 300 c.f.m. respectively. Each has a complete cooling unit located close to its service. Considering the small quantity of air required, recirculation was neglected. Air is taken from the surrounding rooms and cooled to 50 F and then delivered through insulated ducts to mushroom ventilators at the bottom of the glass display cases. The cooling sections are cooled by brine lines from the general service refrigerating plant. Candies and foods are displayed in these cases and are very readily affected by heat. Consequently it was necessary to remove the heat from foods, candies, lights, and air supplies; also the heat transmitted through the glass enclosures of the cases.



DISPLAY CASES IN THE FOOD SHOP, CANDY SHOP AND DRUG STORE CONCESSION SPACES ARE AIR CONDITIONED TO KEEP THE PRODUCTS ON DISPLAY IN PERFECT PRESERVATION. AIR IS DELIVERED TO THE CASES THROUGH INSULATED DUCTS, AT 50 DEGREES

General Service Refrigeration

The services requiring refrigeration include the drink-

ing water system, food-storage rooms of the kitchen and bake shop, ice-cream manufacturing process dairy department, display cases and cold air boxes in the drug store and food shop and food storage and display in the lunch room for the Harvey concession spaces. To provide for these services two 50-ton absorption refrigerating units were installed. In addition, the air conditioning entails the use of the separate 75-ton unit mentioned.

All of this equipment is located in the 72.5 level story east and adjacent to the joint drive.

The two machines are equipped to deliver brine of two temperatures, 15 F to services in the kitchen, lunch room, drug store, and dairy department and 0 to —5 F for ice cream freezing in the dairy department. Brine is circulated through a 6-in. supply and return lines by two centrifugal pumps, capacity 350 g.p.m. against a discharge pressure of 50 lb., direct-connected to 20 hp., 1,800 r.p.m. motors, for all general services. Each pump has a capacity to circulate the full amount of brine required.

Two centrifugal pumps deliver low temperature brine to the ice cream freezing and hardening room in the dairy department, 85.0 level, through separate 2-in. supply and return lines from the refrigeration room. These pumps have a capacity of 50 g.p.m. against a discharge pressure of 50 lb. per sq. in. each and are direct-connected to 5 hp., 1,800 r.p.m. motors. Each pump has a capacity to circulate the full amount of brine necessary.

Cooling coils for all services have a gate valve installed on the supply and return line and a lock shield globe valve in the return line, in an accessible location near the coil. The flow of brine through the coils is regulated by a lock shield valve.

In addition to the refrigeration machines described, a 15-ton unit is installed in a small room in the 72.5 level, north end, adjacent to the kitchen for the sandwich shop. This unit consists of two brine pumps, one drinking water pump and compressor and renders services for drinking water and food storage in the kitchens, sandwich shop, and dining room in the north portion. Owing to the building construction it was impossible to service those spaces from the main plant.

Designers and Constructors

The design and construction for this project, including the terminal and air rights buildings, was commenced some eight years ago under the supervision of H. D. Jouett, chief engineer for the Terminals company. Graham, Anderson, Probst, and White, Chicago, were selected as architects and engineers. All mechanical work in the track level was under the supervision of the Cleveland Union Terminals Co., and above this story under the direction of the architects. Aronberg-Fried Company, Inc., New York and Cleveland, were the general contractors, The A. R. Brueggeman Company was the plumbing and heating contractor, and The Jacob Halter Sons Co., of Cleveland, was the ventilating contractor.

Some Reports on Research

Office Building Windows Weather-Stripped; "Before-And-After" Boiler Plant Records of Interest

Transportation Building, Chicago, Reports Saving

The records of the Transportation building (Chicago) report a large saving of its weather-stripping installation costs in a single year. During windy blizzards complaints from tenants of cold offices had been numerous. The weather-stripping restored the heat balance and showed actual savings in the boiler room which amounted to $7,581.30 in one year.

The boiler plant records of the Transportation building are of unusual interest. Operation data are divided to correspond with the shift. Supervision is flexible and it is always based upon minute and continuous knowledge of what happens within the plant. William H. Seyfarth, superintendent of the building during the period when the weather-stripping was undertaken, kept careful records. He can tell now just what complaints from tenants fell on a given day, and how they have been handled.

C. F. Johnson, manager of the Transportation building, had before him Mr. Seyfarth's figures when he talked on boiler plant economies that had been made effective through weather-stripping. Daily charts showed that plant operation had represented a cost of 64 cents per 1,000 pounds of steam produced when $7.25 coal was used, and that this cost mounted to $0.90 when $4.00 coal was substituted.

The average steam requirement over the five year period from 1921 to 1926 was 22,000,000 pounds per year. The steam consumption showed an average of 5.14 pounds per cubic foot of space. It represented an average of 491 pounds of steam per square foot of radiation per season.

The Transportation building is a tall, narrow structure with broad frontage on the east and narrow elevations on the north and south. All four sides of the 23-story building are exposed. The building has 1 square foot of glass area for every 3.74 square feet of exposed walls, or 1 square foot of window space for every 7.5 sq. ft. of floor area. Prevailing winds are slightly north of west, and the narrow dimensions of the building from wall to wall are such that, unprotected, the air currents

WEATHER-STRIPPING RESTORED THE PROPER HEAT BALANCE IN THIS CHICAGO OFFICE BUILDING.

from window seepage during a storm upset all heating balance.

The building is heated by a vacuum-vapor system from three 250 hp. high pressure, water tube, chain grate boilers.

Evaporation ratios have been made the measure of efficiency, and close attention to detail has increased them from 4 pounds of steam for 1 pound of coal consumed in 1917, to 7 pounds in 1925 for every pound of coal, with a cost of 64.7 cents per 1,000 pounds of steam in 1925.

But windy days formerly upset all schedules, and tenants in some tiers of rooms had to shut up their offices and quit work when sudden shifts of wind took place with rapidly falling temperatures. Attention had been focused on the windows. Heat leakage was apparently the trouble.

The window stripping began in 1925 and was carried through gradually until 968 double hung windows on the west and north exposures (800 on the west, 168 on the north) had been treated. The sashes measured 58 in. x 42 in. x 42 in., that is, each single sash measured 58 in. x 42 in. The entire perimeter of the window and the meeting rails were treated. This work required 27,588 feet of weather stripping. The cost was $5,652.00 installed.

"The work was started at the top," states Mr. Seyfarth, "and the upper half of the building had been completed when severe weather changes proved the value of the procedure. Everything above the twelfth floor was satisfactory as to tenants' comfort. Tenants on these floors worked on as usual in their shirt sleeves. Tenants below the twelfth floor were not so fortunate; their rooms could not be heated. They closed up shop and left."

Coal consumption was checked for the three years just preceding the installation described, and for three years just after the work was done. The figures show that to heat the building containing 60,000 feet of radiation 67,000,000 pounds of steam were used during the three winter periods of five months each from 1920 to 1923, when the outside average mean temperature was 44 degrees.

After the expenditure of $5,652.00 for weather strips, the steam consumption during three similar periods from 1923 to 1926, when the mean average temperature was 33 degrees, was 65,000,000 pounds of steam.

During the period first named 67,000,000 pounds of steam were required for heating with a temperature difference of 26 F (44 to 70 degrees), or 1,118.6 pounds per foot, or 42.95 pounds per foot per degree rise.

During the period subsequent to the weather stripping, 65,000,000 pounds of steam were required for heating with a temperature difference of 37 degrees (70-33 degrees), or 1,083.6 pounds per foot, or the equivalent of 29.29 pounds per foot per degree rise.

The saving due to weather stripping was 13.66 pounds per foot per degree rise. In the period of 1923 to 1926, therefore, the saving would represent 13.66 pounds for 60,000 feet of radiation for a 37-deg. rise in temperature, or 30,325,200 pounds of steam saved. At $0.75 per thousand pounds, the saving would be $22,744, or an average of $7,581.30 per year.—*S. P. M.*

Vest Pocket Handbook

"The Engineer's Vest Pocket Book" is a handy manual containing tables and information on mathematics, statics and dynamics, strength of materials, building construction, mechanical design, heat, hydraulics, chemistry and physics, electricity, transportation, surveying and costs. According to the author, W. A. Thomas, the book is intended to provide a finger-tip reference, afford the student a perspective of engineering, and help the specialist in one branch understand the specialist in a related branch of engineering. A classified directory of many manufacturers appears as an appendix.

Perhaps an objection to the book is that it contains such a variety of information that much of it is too condensed. However it should prove a useful "field handbook" to engineers in every branch of the profession.

The manual is 3 by 5½ in. in size, attractively bound. Published by W. A. Thomas Co., 4554 Broadway, Chicago, its price is three dollars.

Hay Fever

D. O. N. Lindberg*

I FIND MYSELF quite in accord, from practically every standpoint, with the writer of the article on hay fever, which appeared in a recent number of your publication.[1] We must realize that hay fever is an allergic condition, so that all individuals exposed to pollen sources, for example, do not react similarly. Then, too, in discussing the subject "hay fever" one must not lose sight of the fact that pollen dust is but a single source of allergic reaction. Hay fever may be brought about by bacterial toxins within the body, certain foods, etc. In other words, the most troublesome factor in hay fever at the present time is in dealing with the non-pollen causes.

Washed air would, as, according to the author, be welcome in the field of industrial medicine, where its use might eliminate dust and fumes. The chief use in hospitals would be to eliminate, whenever possible, the obnoxious odors that are present for many hours each day.

* Medical Director and Supt., Macon County Tuberculosis Sanitarium, Decatur, Ill.

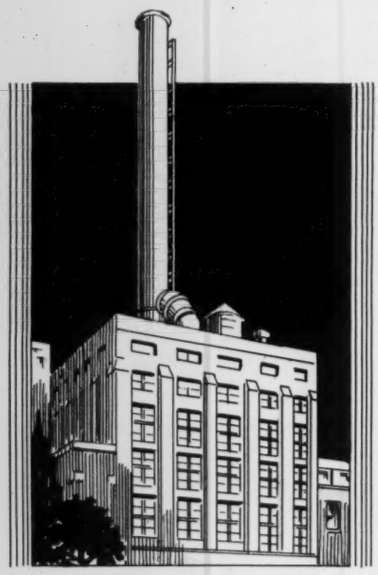
[1] *Hay Fever.* HEATING, PIPING AND AIR CONDITIONING, October, 1930, p. 843.

"Open for Discussion"

Planning and Installing District Heating Mains

Locating Underground Lines Involves Compromises

By B. M. Conaty*



THE engineer in charge of location and construction of district heating mains has perhaps the most difficult problem to be encountered in underground street structures, for while water and gas mains as well as electric ducts may deviate from the most direct line and grade without penalty, steam mains are not flexible. Grade and line are vitally important for proper operation of the steam line and any deviation not carefully worked out and provided for may be the source of endless operating trouble. Compromises are required of the engineer from the first step in the construction of heating mains to the last.

Every one in this field of work must have experienced the careful preparation of locations only to find that underground structures seem to have the habit of not being exactly where shown on plans with the result that after the construction has started, obstructions appear which necessitate a change of grade or line, or both.

Initially then, the engineer must determine just how much time and money can be invested economically in plans, and in this lies the first required compromise. In cities where accurate data is available as to location of existing structures, careful planning will be reflected in construction economies, but where the available data is meager, locations are inaccurate and the completed line not reasonably in accord with the proposed location, as shown on the plans, it is possible that in subsequent work some of the time and money spent on the plans might better be used sinking test pits and planning locations directly ahead of the actual construction. The methods outlined in the article in your October number might well be used as a guide.[1]

Stay Near Surface

Obstructions and interference in the route of the steam line continually confront the engineer and require careful study on his part as to the relative economy of moving the obstruction or avoiding it. The latter course most frequently means locating the steam line at a greater depth and if a general rule were to be laid down for the guidance of the engineer, it might well be the brief one "Stay up."

Rock and Sub-surface Water

As the distance from the surface is increased, the construction costs mount and the rate of increase is generally not a direct ratio. Obviously, the cost of excavation is greater, but in addition to this there is the danger of encountering rock or sub-surface water conditions which make construction both difficult and expensive, as well as increasing costs of operation and maintenance. Unfortunately, no specific rules can be formulated and as a result every obstruction in the route of a steam line must be weighed in itself; but in the opinion of this writer any obstruction which necessitates appreciable depression of the steam line should be carefully studied with a view towards moving it.

Use of Bends to Pass Obstructions

Street intersections, of course, present the greatest difficulty to the engineer and at these points it is sometimes strategy to deviate from straight line construction and utilize one or more pipe bends to pass between obstructions rather than go under them. Where this course is pursued, a steel sleeve fitted to and welded over the insulation offers the required protection and at the same time provides flexibility to permit the bends the necessary freedom of movement for taking up line expansion.

* American District Steam Co., North Tonawanda, N. Y.

[1] *Determining the Location of District Heating Mains*, by John F. Collins, Jr. HEATING, PIPING AND AIR CONDITIONING, October, 1930, p. 817.

Heating·Piping
and Air Conditioning

American Society of Heating and Ventilating Engineers
JOURNAL SECTION

MARCH 1931

Material in this Section prepared by Publication Committee: W. A. Rowe, *Chairman;* E. O. Eastwood, and F. D. Mensing : A. V. Hutchinson, Manager of Publications

Table of Contents

Wind Velocity Gradients Near a Surface and Their Effect on Film Conductance, by F. C. Houghten and Paul McDermott 229
Proceedings of the 37th Annual Meeting 238
Local Chapter Reports 264
Candidates for Membership 269
Candidates Elected 270

OFFICERS AND COUNCIL 1931

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
51 Madison Ave., New York, N. Y.

President ..... W. H. CARRIER
First Vice-President ..... F. B. ROWLEY
Second Vice-President ..... W. T. JONES
Treasurer ..... F. D. MENSING
Secretary ..... A. V. HUTCHINSON
Technical Secretary ..... PAUL D. CLOSE

COUNCIL

W. H. CARRIER, *Chairman* — F. B. ROWLEY, *Vice-Chairman*

One Year

E. B. LANGENBERG — G. L. LARSON — W. A. ROWE — F. C. McINTOSH

Two Years

D. S. BOYDEN — R. H. CARPENTER — JOHN HOWATT — J. D. CASSELL

Three Years

E. K. CAMPBELL — E. O. EASTWOOD — E. HOLT GURNEY — ROSWELL FARNHAM

COMMITTEES OF THE COUNCIL

Executive: F. B. ROWLEY, *Chairman*
D. S. BOYDEN — J. D. CASSELL

Finance: F. C. McINTOSH, *Chairman*
JOHN HOWATT — W. T. JONES

Membership: ROSWELL FARNHAM, *Chairman*
R. H. CARPENTER — E. B. LANGENBERG

Publication: W. A. ROWE, *Chairman*
E. O. EASTWOOD — F. D. MENSING

ADVISORY COUNCIL

L. A. Harding, *Chairman;* Homer Addams, F. Paul Anderson, R. P. Bolton, S. E. Dibble, W. H. Driscoll, H. P. Gant, John F. Hale, H. M. Hart, E. Vernon Hill, J. D. Hoffman, S. A. Jellett, D. D. Kimball, S. R. Lewis, Thornton Lewis, J. I. Lyle, J. R. McColl, D. M. Quay, C. L. Riley, F. R. Still and A. C. Willard.

SPECIAL COMMITTEES

Committee on Meetings Program: G. L. Larson, *Chairman;* J. J. Aeberly and L. A. Harding.

Guide Publication Committee: D. S. Boyden, *Chairman;* W. L. Fleisher, H. S. Haley, S. R. Lewis and L. T. M. Ralston.

Committee on Code for Testing and Rating Steam Unit Heaters: D. E. French, *Chairman;* O. K. Dyer, G. E. Otis, W. A. Rowe, L. C. Soule, J. H. Schrock and H. W. Page.

Committee on Code for Testing and Rating Concealed Gravity Type Radiation: R. N. Trane, *Chairman;* E. H. Beling, W. F. Goodnow, John Holton, Hugo Hutzel, A. P. Kratz, E. J. Vermere and O. G. Wendel.

Committee on Code for Testing and Rating Unit Ventilators: John Howatt, *Chairman;* C. P. Bridges, S. E. Dibble, Warren Ewald, L. D. Harnett, G. E. Otis, R. C. Ott.

Committee on Increase of Membership: C. W. Farrar, *Chairman;* E. K. Campbell and E. H. Gurney.

Committee on Natural Ventilation: J. E. Emswiler, *Chairman;* W. C. Randall and A. Vogel.

Committee on Rating and Testing Low Pressure Heating Boilers: R. V. Frost, *Chairman;* H. M. Hart, F. C. Houghten, H. F. Hutzel and Raymond Newcomb.

Committee on Revision of Constitution and By-Laws: Thornton Lewis, *Chairman;* W. T. Jones and F. R. Still.

Committee on Code of Minimum Requirements for the Heating and Ventilation of Buildings: Perry West, *Chairman;* C. A. Booth, W. H. Driscoll, L. A. Harding, W. A. Rowe and A. C. Willard.

Committee on Ventilation Standards: J. R. McColl, *Chairman;* A. C. Willard, W. H. Driscoll, W. A. Rowe, F. Paul Anderson, D. D. Kimball, C. L. Riley, J. J. Aeberly.

NOMINATING COMMITTEE FOR 1931

Chapters	*Representative*	*Alternate*
Cleveland	H. M. Nobis	
Illinois	H. M. Hart	E. P. Heckel
Kansas City	N. W. Downes	J. M. Arthur
Massachusetts	David Moulton	
Michigan	J. F. McIntire	J. R. McColl
Minnesota	M. S. Wunderlich	
New York	Russell Donnelly	R. A. Wolff
Western New York	F. H. Burke	Joseph Davis
Ontario	H. J. Church	
Pacific Northwest	E. O. Eastwood	W. E. Beggs
Philadelphia	R. C. Bolsinger	C. V. Haynes
Pittsburgh	F. C. McIntosh	F. A. Gunther
St. Louis	C. A. Pickett	J. L. DeNeille
Southern California	E. C. Evans	R. L. Gifford
Wisconsin	E. A. Jones	Ernest Szekely

COMMITTEE ON RESEARCH

C. V. HAYNES, *Chairman*

F. B. HOWELL, *Vice-Chairman* — F. C. HOUGHTEN, *Director*

O. P. HOOD, *Ex-Officio Member*

One Year

O. W. ARMSPACH, R. S. FRANKLIN, F. E. GIESECKE, A. P. KRATZ, A. E. STACEY

Two Years

C. V. HAYNES, W. T. JONES, J. F. MCINTIRE, F. N. SPELLER, A. C. WILLARD

Three Years

C. A. BOOTH, F. B. HOWELL, W. L. KLIE, F. B. ROWLEY, J. H. WALKER

Executive Committee

C. V. HAYNES, *Chairman*

J. F. MCINTIRE, W. T. JONES

TECHNICAL ADVISORY COMMITTEES - 1931-1932

Air Conditions and Their Relation to Living Comfort: C. P. Yaglou, *Chairman;* O. W. Armspach, W. L. Fleisher, Dr. E. V. Hill, Dr. R. R. Sayers.

Air Flow Through Registers and Grilles: John Howatt, *Chairman;* J. J. Aeberly, C. A. Booth, L. E. Davies, D. E. French and J. J. Haines.

Atmospheric Dust and Air Cleaning Devices (Including Dust and Smoke): H. C. Murphy, *Chairman;* Albert Buenger, Philip Drinker, Dr. E. V. Hill, H. B. Meller and Dr. S. W. Wynne.

Correlating Thermal Research: J. C. Fitts, *Chairman;* D. S. Boyden, P. D. Close, R. M. Conner, W. T. Jones and Perry West.

Heat Transmission (Heat received by and emitted by buildings, in relation to living comfort): L. A. Harding, *Chairman;* R. E. Backstrom, F. B. Rowley, A. E. Stacey and J. H. Walker.

Infiltration in Buildings: G. L. Larson, *Chairman;* J. E. Emswiler, F. E. Giesecke, W. C. Randall, W. A. Rowe, J. G. Shodron, Ernest Szekely and M. S. Wunderlich.

Oil and Gas Burning Devices: L. E. Seeley, *Chairman;* R. M. Conner, P. E. Fansler, R. S. Franklin, R. V. Frost, R. C. Morgan and H. F. Tapp.

Pipe and Tubing (Sizes) Carrying Low Pressure Steam or Hot Water: S. R. Lewis, *Chairman;* J. C. Fitts, F. E. Giesecke, H. M. Hart, A. P. Kratz, W. M. Robinson and W. K. Simpson.

Radiation—Direct and Indirect: John Holton, *Chairman;* R. M. Conner, R. E. Daley, R. V. Frost, F. E. Giesecke, H. F. Hutzel, A. P. Kratz, J. F. McIntire, W. T. Miller and R. N. Trane.

Sound in Relation to Heating and Ventilation: F. B. Rowley, *Chairman;* Carl Ashley, Warren Ewald, R. F. Norris and G. T. Stanton.

Ventilation of Garages and Bus Terminals: E. K. Campbell, *Chairman;* D. S. Boyden, H. P. Gant, W. T. Jones and W. C. Randall.

OFFICERS OF LOCAL CHAPTERS 1931-32

CLEVELAND

Headquarters, Cleveland

Meets: Second Friday in Month

President, F. H. MORRIS
5203 Hamilton Ave.

Secretary, R. G. DAVIS
887 Nela View Rd.

ILLINOIS

Headquarters, Chicago

Meets: Second Monday in Month

President, A. G. SUTCLIFFE
4146 N. St. Louis Ave.

Secretary, C. W. DELAND
211 N. Desplaines St.

KANSAS CITY

Headquarters, Kansas City, Mo.

Meets: Second Monday in Month

President, E. K. CAMPBELL
2441 Charlotte St.

Secretary, W. A. RUSSELL
235 Ward Pkwy.

MASSACHUSETTS

Headquarters, Boston

Meets: First Monday in Month

President, T. F. MCCOY
125 St. Botolph St.

Secretary, LESLIE CLOUGH
80 Boylston St.

MICHIGAN

Headquarters, Detroit

Meets: First Monday after the 10th of the Month

President, E. E. DUBRY
9116 Dexter Blvd.

Secretary, E. H. CLARK
606 Michigan Theatre Bldg.

MINNESOTA

Headquarters, Minneapolis

Meets: Second Monday in Month

President, D. M. FORFAR
240 Seventh Avenue South

Secretary, W. F. UHL
132 S. Tenth St.

NEW YORK

Headquarters, New York

Meets: Third Monday in Month

President, A. J. OFFNER
1182 Broadway

Secretary, W. A. SWAIN
80 White St.

WESTERN NEW YORK

Headquarters, Buffalo

Meets: First Monday in Month

President, JOSEPH DAVIS
85 Warren Ave.
Kenmore, N. Y.

Secretary, J. J. LANDERS
303 Crosby Bldg.

ONTARIO

Headquarters, Toronto, Can.

Meets: First Monday Every Other Month

President, H. J. CHURCH
137 Wellington W.

Secretary, H. R. ROTH
1104 Bay St.

PACIFIC NORTHWEST

Headquarters, Seattle, Wash.

Meets: Second Thursday in Month

President, E. O. EASTWOOD
University of Washington

Secretary, M. ANDERSON
2467 Westmont Way

PHILADELPHIA

Headquarters, Philadelphia

Meets: Second Thursday in Month

President, E. N. SANBERN
1520 Locust St.

Secretary, W. P. CULBERT
2019 Rittenhouse St.

PITTSBURGH

Headquarters, Pittsburgh

Meets: First Monday in Month

President, F. C. HOUGHTEN
4800 Forbes St.

Secretary, J. L. BLACKSHAW
3752 Beechwood Blvd.

ST. LOUIS

Headquarters, St. Louis

Meets: First Wednesday in Month

President, R. M. ROSEBROUGH
4246 Forest Park Blvd.

Secretary, C. R. DAVIS
2328 Locust St.

SOUTHERN CALIFORNIA

Headquarters, Los Angeles

Meets: First Tuesday after the 10th of the Month

President, O. W. OTT
1100 Washington Bldg.

Secretary, H. B. KEELING
305 Union Insurance Bldg.

WISCONSIN

Headquarters, Milwaukee

Meets: Third Monday in Month

President, J. G. SHODRON
411 E. Milwaukee Ave.
Ft. Atkinson, Wis.

Secretary, H. F. HAUPT
170 Beaumont Ave.

Wind Velocity Gradients Near a Surface and Their Effect on Film Conductance

By F. C. Houghten[1] (*MEMBER*) and Paul McDermott[2] (*NON-MEMBER*), Pittsburgh, Pa.

DURING the past few years considerable research has been directed towards a study of heat transfer coefficients and their application to heat flow through typical building constructions under natural conditions of weather.

As a result of these studies, students of heat transfer and designing engineers have greater confidence in the application of the formula[3] for the calculation of overall coefficients from coefficients for the component factors which go to make up the total resistance to heat flow through a wall. At the present time the only factors in the heat transmission equation which are not accepted with confidence are the film conductance coefficients f_i and f_o for inside and outside wall surfaces. Confidence is particularly lacking in the outside coefficients for different walls for various weather and wind conditions.

The reason for lack of confidence in the available surface conductance coefficients is not found in insurmountable difficulties encountered in determining these values for any particular condition, but rather in difficulties encountered in the application to practical conditions of available coefficients determined under some particular test arrangement. The most important factor affecting the application of the coefficients is the prevailing wind and its effect on air velocities near the wall surface.

A coefficient may be determined with great accuracy in the laboratory in a particular piece of apparatus where a uniform wind velocity is maintained parallel to, and measured at some definite distance away from, the surface. This value is reported as applying to a wind velocity equal to that measured in the experimental apparatus. There is no assurance of the application of this coefficient to a wall subjected to any particular wind velocity in open space.

In order to establish data on the effect of wind velocity gradients near a surface on film conductance, the A. S. H. V. E. laboratory undertook a study of the subject in accordance with a plan outlined by the 1928 Technical Advisory Committee on Heat Transmission under the chairmanship of L. A. Harding. The problem as outlined included two rather distinct phases; *first,* a study of the effect of direction and location of measurement of wind velocity near a surface on the film conductance coefficient; and *second,* a study of wind velocity gradients near a wall in free space and in a confining duct. This report includes data on both phases of this subject based on the direction of the wind parallel to the surface. It does not touch upon the more complicated problem of determining these effects when the wind impinges against a wall at some other angle.

[1] F. C. Houghten, Director, A. S. H. V. E. Research Laboratory.
[2] Paul McDermott, Research Engineer, A. S. H. V. E. Research Laboratory.
[3] See Chapter 3, A. S. H. V. E. GUIDE 1931.
Presented at the 37th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Pittsburgh, Pa., January, 1931.

Determination of Film Conductance Coefficients

The apparatus used for studying the effect of wind velocity gradients and confining duct size on film conductance coefficients is shown in Fig. 1. The desired air velocities through the 24-ft duct, including the test section, were produced by the fan. Vane deflectors were placed in both the vertical and horizontal dimensions of the duct near the fan outlet. These were adjusted to give natural distribution of flow. A window screen resistance was placed just beyond the deflectors, to further aid in obtaining natural distribution. A short distance beyond this resistance the entire cross section of the duct was filled with sheet metal tubes, 2 in. in diameter and 2 ft in length, so placed that the air had to pass through them. This had the effect of straightening out any swirling motion of the air.

The duct was 12 in. x 14 in. with the 12-in. dimension horizontal and built with particular care so as to give smooth, even sides. The joints were flanged and particular care was taken to insure that the inside surfaces of the duct through the flanged joints were even. In order to determine the effect of the width of the duct perpendicular to the test surface on the film conductance coefficient, the temperature gradient, and the wind velocity gradient away from the surface, provision was made for dividing the duct into two equal parts by a vertical partition through the center. This made it possible to study, in both a 6-in. and a 12-in. duct, the phenomena described.

The test surface was set up in the enlarged test section of the duct in such a way that its surface was in the plane of one of the vertical sides. A thermocouple was arranged so that the temperature gradient away from the test surface across the greater part of the width of the duct could be surveyed. The copper constantan thermocouple, of No. 36 B and S wire, was held by two prongs of a fork so that its junction and one inch of the wire on either side of it were located in the isothermal plane. Pitot tubes were arranged so that the velocity gradients throughout both the horizontal and vertical dimensions of the duct could be surveyed. A control thermocouple and a control Pitot tube were provided in order to check any change in conditions during a survey.

The enlarged section *B*, Fig. 1, shows the arrangement of the surface and heater and the method of applying heat to the surface. The heater consisted of two standard guarded hot plates designated as *main* guarded hot plate and *auxiliary* guarded hot plate. These were separated by a high resistance heat flow meter. The heat input into the main guarded hot plate was adjusted so as to maintain the desired temperature of the test sur-

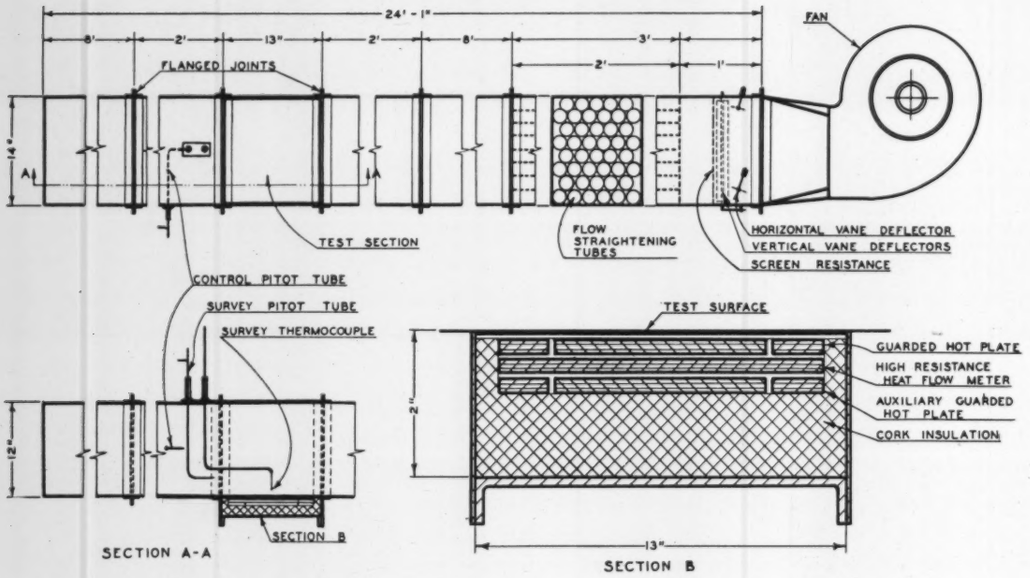


FIG. 1—APPARATUS FOR STUDYING EFFECT OF WIND VELOCITY GRADIENTS ON FILM CONDUCTANCES

face. The heat input into the auxiliary guarded hot plate was then adjusted so that no temperature difference or heat flow was indicated through the high resistance heat flow meter. Under these conditions all of the heat developed in the center of the main guarded hot plate necessarily flowed outward through the test surface.

The test surfaces were made as thin as possible and cemented directly to the copper face of the main guarded hot plate so as to offer as little resistance as possible to the flow of heat from the main heater to the surface. The heaters were 12 in. square with ½-in. cork insulation around the edges. The test surface, 13 in. square, joined the 12x14-in. duct, at either end of the test section, in a smooth plane.

In making a test the surface studied was maintained at the desired temperature and the guard ring of the main heater, the auxiliary heater, and its guard ring were adjusted to the same temperature. These conditions were maintained for a sufficient length of time to establish equilibrium of heat flow between the surface and the air. The temperature and velocity of the air through the duct were maintained constant. The heat dissipated from the surface was calculated from the electrical input supplied to the center section of the main heater. The film conductance coefficient was calculated from the formula

$$f = \frac{EIJ}{A\,(t_s - t_a)} = \frac{H}{t_s - t_a} \qquad (1)$$

where

I = current input in amperes.
E = emf across the effective part of the heater.
J = the equivalent of heat = 3.415 Btu per hour.
A = area of the heater winding or the center of the main guarded hot plate in square feet.
t_s = temperature of the test surface.
t_a = temperature of the air in the center of the duct.
H = heat input by the heater in Btu per square foot per hour.
f = the film conductance coefficient in Btu per square foot per hour per degree temperature difference between the surface and the air.

Tests were made for a large number of velocities ranging from 1 mph, the lowest which could be maintained uniformly, to a maximum of 35 miles per hour for the 6-in. duct, and 20 mph for the 12-in. duct.

The film conductance coefficient for the painted sanded surface in the 12-in. duct and for the smooth white pine surface in the 12-in. and 6-in. ducts are plotted against wind velocity in Fig. 2. The painted sanded surface was made by cementing paper directly to the copper face of the main heater, and then applying to the paper a single coat of light gray paint. While the paint was still soft, sand which was graded to pass through a 60 mesh sieve and over an 80 mesh sieve was sprinkled evenly over the surface so as to give a distribution of approximately one grain of sand per 1/16-in. center. After the first coat of paint into which the sand had been sprinkled was dry, the sanded surface was painted a second single

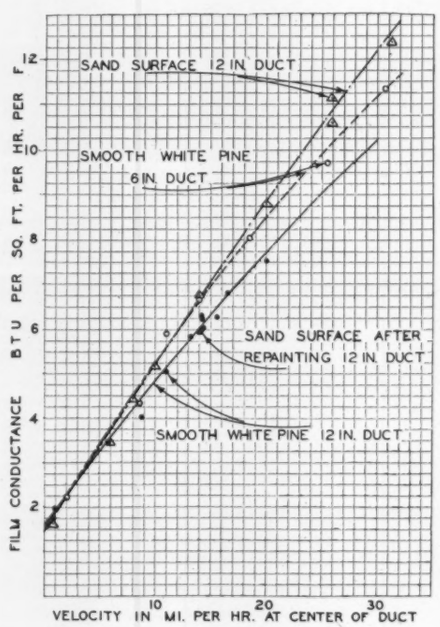


FIG. 2—FILM CONDUCTANCE COEFFICIENTS FOR SMOOTH PINE AND SANDED SURFACES AT VARIOUS AIR VELOCITIES

coat. This left each grain of sand covered with a paint film in such a way that the shape and size of the grains stood out rather distinctly in the painted surface. This surface was taken to simulate a painted, sand finish plaster. After obtaining the values for this surface plotted in Fig. 2, the surface was painted an additional two coats of the same grade of paint. These coats of paint tended to fill up the spaces between the sand grains and to smooth off the surface so as to produce a fairly smooth surface with rounded bumps. Three tests were made on this surface for a wind velocity of approximately 14 mph resulting in the points in squares showing a film conductance coefficient considerably lower than the values for the rough sanded surface. The paint used was mixed at the laboratory and consisted of 71 per cent of white lead ground in oil, 23 per cent white zinc ground in oil, 6 per cent boiled linseed oil, sufficient turpentine to give proper paint consistency and enough lamp black to give a light gray tinge.

The smooth white pine surface, made by planing and sanding a board down to a thickness of 1/16 in. and cementing it to the copper face of the main heater, was adjusted so that its exposed surface lay in the plane of the duct wall. The curves in Fig. 2 show the relationship between the film conductance coefficients for the smooth pine surface as measured in the 12-in. and 6-in. ducts.

Determination of Wind Velocity Gradients

There are very little data available in the literature on the subject of wind velocity gradients near a surface, and the little that is to be had seems to have been determined on very small surfaces which were in, or which formed part of the walls of a wind tunnel. A large part of the recorded work was done by aerodynamic engineers in the interest of aviation. Often the surface studied was cylindrical, or otherwise curved. Perhaps the best data available on the subject resulted from an investigation by the National Advisory Committee for Aeronautics.[4] The purpose of this study was to determine the distance which had to be allowed around airplane model surfaces in wind tunnels so that obstruction to the wind would not affect velocity over the surface.

The A. S. H. V. E. Laboratory undertook to make a study of wind velocity gradients near a wall sufficiently large to approach somewhat the dimensions of the side of a building. Difficulty in finding winds of the desired velocities over a reasonable period of time made it impractical to depend on natural wind. It was also deemed impractical to produce an artificial wind of the velocities desired over a comparatively large wall and for a considerable distance away from it so as to get a natural gradient effect.

It was early agreed by those interested in the study that the equivalent of a wind against a surface could most easily be had by moving the wall forward at the desired speed while attached to the side of a car. However, there was considerable doubt concerning the possibility of measuring the small pressures set up at the various distances from the wall with gages located on the moving machine.

Preliminary tests showed that the liquid in the pressure gages moved around considerably due to acceleration and change in the level of the instrument. It was quite evident that it would be impossible to establish the desired gradient by taking successive readings at different distances from the wall surface. It did seem possible, however, to make the surveys with several Pitot tubes each connected to its own pressure gage column, located on the same instrument base so that all tubes would be subjected at any instant to the same disturbing forces. It also seemed possible that these various manometer tubes and the levels of the colored oil in them might be photographed at frequent intervals for later analysis. This method of attack was attempted and proved surprisingly successful.

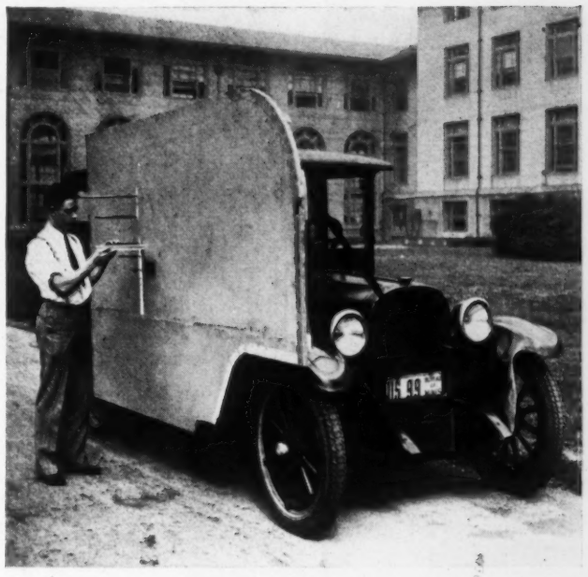


FIG. 3—TEST WALL WITH PITOT TUBES IN PLACE FOR STUDYING WIND VELOCITY GRADIENTS

Fig. 3 is a photograph of the wall in place on the truck with the 10 Pitot tubes. Fig. 4 is a drawing of the wall which was 10 ft in length and 6 ft high. When it was attached to the truck, the front end was placed slightly ahead of the most forward part of the truck, so as to prevent air waves set up by the moving truck from passing around the front end of the wall. The upper front corner of the wall was curved off so as to pass through the air with less wave disturbance, and the lower front was cut away to avoid interference with turning of the front wheel.

Pitot tubes were used for measuring air velocity at the various distances from the surface. They were mounted in a vertical series 2 ft in length. The upper tube was 18 in. and the lower tube was 30 in. from the top and bottom edges of the wall, respectively. This series consisting of 10 tubes was 7 ft from the front edge and 3 ft from the back edge of the wall.

Standard Pitot tubes were used to measure the velocity at points 1 in. and farther from the surface. Special tubes made from hypodermic needle tubing having an outside diameter of 0.0720 in. and an inside diameter of 0.0521 in. were used at points from 1/16 to 2 in. from the surface. These were calibrated by comparing their dynamic pressures with those of the standard tubes at the same distance from the surface

[4] *Effect of Walls in Closed Type Wind Tunnels*, by George J. Higgins (Report 275, National Advisory Committee for Aeronautics).

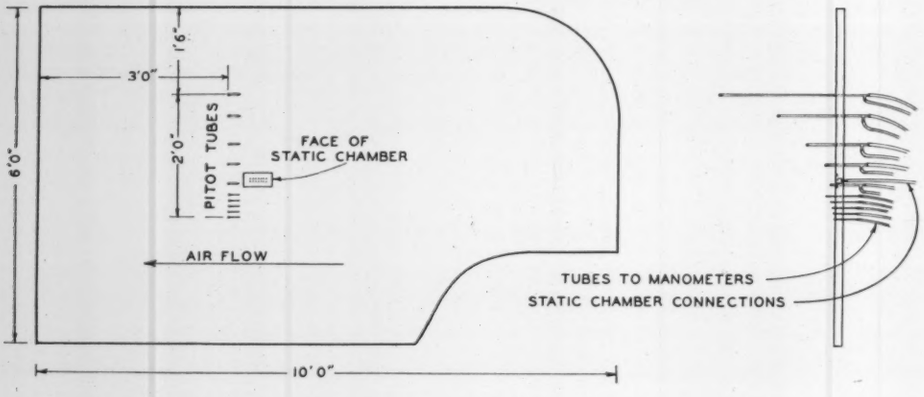


FIG. 4—TEST WALL SHOWING LOCATION OF PITOT TUBES

and with the same air velocity. They were single bore tubes for indicating dynamic pressures only.

A special static pressure chamber, Fig. 5, was used with the small tubes. It consisted of a brass plate ⅛ x 3x6 in. on the back of which was soldered a brass box 4 in. long and having a cross section 1 in. square. Two rows of seven 0.040-in. holes were drilled through the plate into the box to serve as static openings. Three ¼-in. brass tubes were joined to the back of the box for manometer connections. The chamber was mounted near the small tubes so that the surface of the brass plate lay in the plane of the wall. The static pressure produced in the chamber was found to be the same as that produced by the static openings of the standard tubes for any wind velocity.

The static and dynamic connections of each Pitot tube were connected to the two legs of its inclined U-tube in the compound pressure gage. The single small dynamic tubes were each connected to one leg of one of the U-tubes. The other leg was connected to the special static chamber.

The range of distances from the surface to the dynamic orifices of the tubes used was with the small tubes at 1/16, ¼, ½, 1, and 2 in. and the large tubes at 1, 2, 6, 12, and 24 in. from the surface. The number of tubes was limited to ten by the number of manometer tubes which could be accommodated on the inclined gage platform. This arrangement gave eight different distances from the surface and by having both a large and small tube at 1 and 2 in. a check was provided on the readings of the two types of tubes. The data submitted were taken with such an arrangement.

The compound pressure gage with the inclined U-tubes and the camera and lighting arrangement for photographing the tubes are shown in Fig. 6. Records of manometer readings were made with a moving picture camera using a standard 35 mm film and adjustable to make exposures at rates of from 1 to 16 per second or still exposures of any desired time.

Besides the 10 U-tubes on the inclined plane of the gage, there were also two leveling tubes, one transverse to the direction of the U-tubes which indicated any change in transverse level of the instrument or any transverse acceleration tending to change the level of the liquid in the tubes. The other leveling tube was placed parallel to and on the left hand side of the U-tubes and was so arranged that it would indicate any change in longitudinal level or longitudinal acceleration tending to change the level of the liquid in the tubes. The longitudinal level was so calibrated that if a given photograph showed a deflection for this level the U-tube readings could be corrected for it. No data were used from photographs in which the transverse level showed any appreciable disturbance.

Any individual photograph taken during a test recorded the liquid levels at a particular instant when the levels might be either high or low because of the disturbing forces or lack of level. These variations in level were comparatively small and acted alternately in opposite directions. From a study of a number of con-

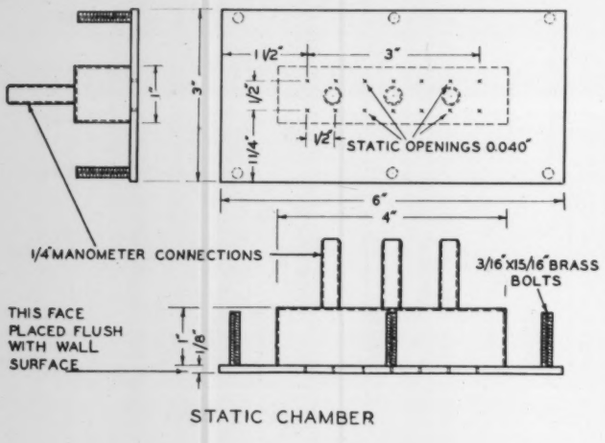


FIG. 5—STATIC CHAMBER FOR MEASURING STATIC PRESSURE AT THE WALL SURFACE

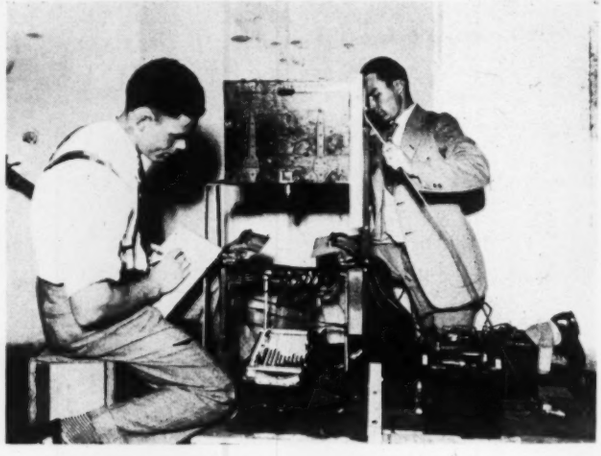


FIG. 6—COMPOUND PRESSURE GAGE AND MOVING PICTURE CAMERA FOR PHOTOGRAPHING OBSERVATIONS

secutive pictures it was found that their average gave a consistent value.

Fig. 7 is a reproduction of one of the moving picture films showing the displacement of the red oil in the inclined U-tubes for a fairly high wind velocity. The single tube at the extreme left indicates longitudinal disturbances. The tube which indicates transverse disturbance is barely visible at the bottom.

Tests were made on a straight, level, and smooth concrete highway recently built a few miles out of Pittsburgh. During the tests the car was run as uniformly as possible at the desired speed, allowing the levels in the various U-tubes to become fairly constant, after which a number of exposures were made. After the negatives were developed they were placed in a small projecting apparatus and thrown on a screen so that the size of the projected picture was considerably larger than the instrument board from which the picture was taken. The enlarged manometer displacements were read and corrected for the ratio between the size of the projected picture and the instrument from which the picture was taken.

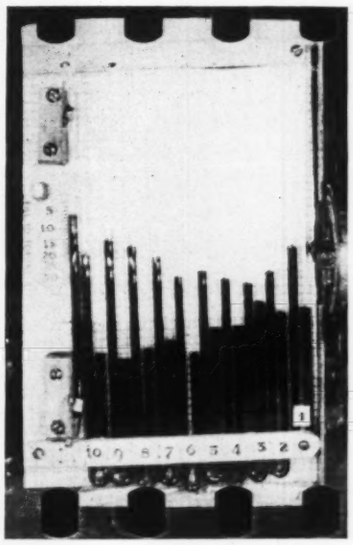


FIG. 7—MOVING PICTURE PHOTOGRAPH OF PRESSURE GAGE DISPLACEMENTS

Fig. 8 gives the velocity gradient away from the wall as determined for a relative air velocity of 30.7 mph (2,700 fpm). The average of many test points observed for this speed at each distance from the wall are indicated by the symbol '△' where the standard Pitot tubes were used and by '•' where the small special tubes were used. It will be noticed that one tube of each type was used at the 1 and 2-in. distances.

Similar curves were plotted for each of the several velocities studied. Points taken from all of the experimental curves similar to Fig. 8 were then plotted for each of the various distances from the wall in Fig. 9. In these curves the maximum velocity shown on the curves (similar to Fig. 8) was plotted on the X axis and the velocities measured at the respective distances X from the wall were plotted on the Y axis. Experimental points are shown for the curve $X = 0.5$. It will be noted that these points all fall remarkably close to the curve, indicating as would be expected that the series of curves of which Fig. 8 is a sample form a family of similar curves. This family of curves is plotted for different velocities in Fig. 10. The solid line curves are plotted from the curves for the various distances in Fig. 9.

Wind velocity gradients away from the test surface in the heat transfer apparatus, Fig. 1, were measured by the survey Pitot tube for both the 12-in. and 6-in. ducts. Fig. 11 gives a sample survey in the 12-in. duct at 8.75 mph and also a sample survey in the 6-in. duct at 14.75 mph. A large number of such surveys were made and plotted. The velocity indicated by these curves at various distances X inches from the surface were plotted against the velocity in the center of the 12-in. duct in Fig. 12 and against the velocity in the center of the 6-in. duct in Fig. 13. From these curves the families of gradient curves for various wind velocities in the two ducts were plotted in Fig. 14. Gradient curves in free space are also shown for comparison.

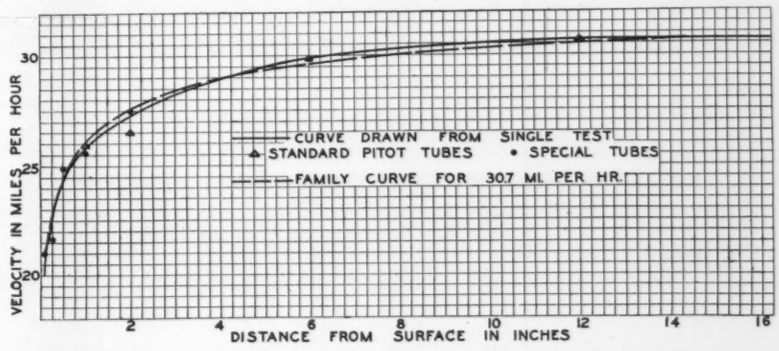


FIG. 8—WIND VELOCITY GRADIENT FOR SINGLE TEST AND FAMILY CURVE FOR THIS VELOCITY

Discussion of Test Results

The curves giving the relation between film conductance and wind velocity in Fig. 2 shows a higher conductance coefficient for the rough surface at high wind

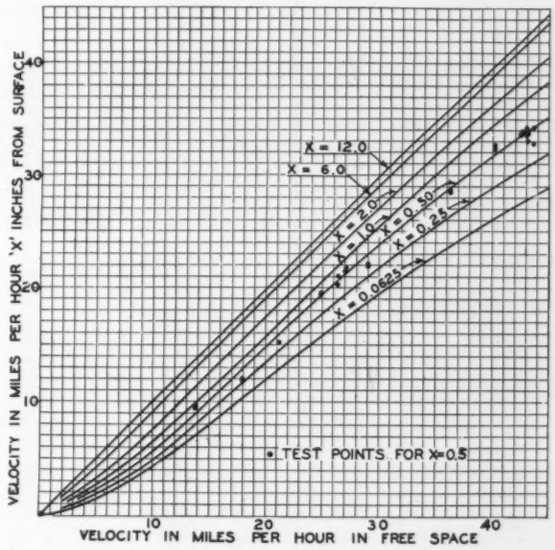


FIG. 9—RELATION BETWEEN VELOCITY IN FREE SPACE AND VELOCITIES AT POINTS DISTANT X FROM THE SURFACE FOR FREE AIR

velocities and apparently a slightly lower coefficient for the same surface for still air and low wind velocities. The low coefficient for the sanded surface at low velocities and still air, while indicated by the data, is so small that it should not be given much consideration. The indicated difference is less than the possible experimental error. The increase in film conductance coefficients for the sanded surface at higher velocities is real and cannot be due to any possible error or unusual test condition. The few tests made on this surface after the application of additional coats of paint had smoothed out the sharp projections of the sand particles indicate that the elimination of the roughness reduced the heat loss to the same value found for the smooth pine surface with the same wind velocity in the center of the same size duct.

There is much speculation concerning the theoretical effect which roughness of surface has on film conductance. It is generally assumed that a rough surface has the effect of holding stagnant air in pockets between the high points producing the roughness. This would increase the thickness of the relatively stationary air film near the major part of the surface and increase the resistance to heat flow from the surface into the air stream. It is probable that certain types of roughness will have this effect while other types of roughness resulting from comparatively few distinct and clear cut projections on the surface will have the effect of extending the surface area without appreciably producing pockets of stagnant air between. It is even possible that these extended particles on the surface may have the effect of producing eddy currents over the surface and into the low spaces between the projection so as actually to produce greater agitation and motion of the air nearest to the surface of the wall.

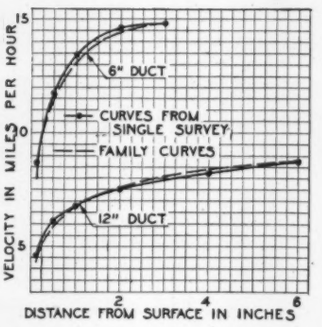


FIG. 11—VELOCITY GRADIENT CURVES IN 12-IN. AND 6-IN. DUCTS SHOWING CURVES FROM SINGLE TEST AND FROM THE FAMILY OF CURVES

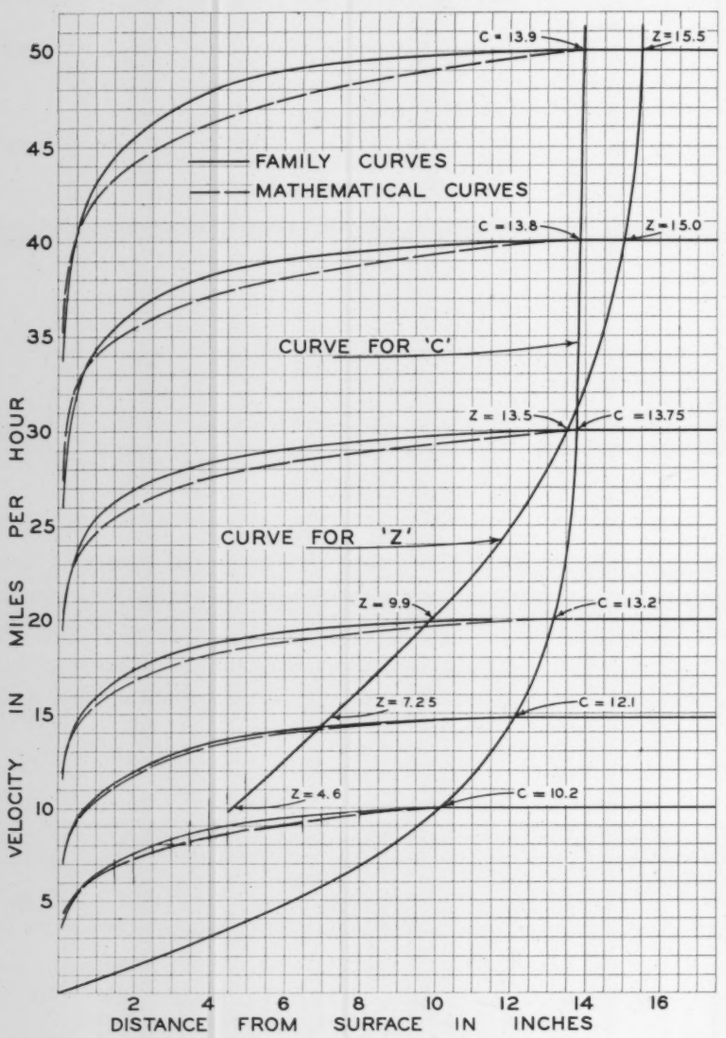


FIG. 10—VELOCITY GRADIENT CURVES AWAY FROM THE WALL. SOLID LINE CURVES FROM TEST DATA[a]

[a] Broken Line Curves from Equation

$$\frac{V_x}{V_2} = \left(\frac{X}{C}\right)^{\frac{1}{Z}}$$

Where C and Z Have the Values Shown.

Film conductance as defined and evaluated includes the heat dissipated from a surface to air by conduction and convection and by radiation to surrounding surfaces and space. Hence the emissivity of the test surface, its absolute temperature and the emissivity and absolute temperature of the surfaces or space which can be seen by the test surface all affect the film conductance.

In determining the film conductance coefficient it is therefore necessary to take radiation into account. The coefficients here reported were determined with the parts of the apparatus in view of the test surface at an air temperature within plus or minus one degree. This was accomplished by using a low air temperature of 70 F which was the same as the temperature of the room in which the apparatus was located.

It is of interest to note the effect which variation in temperature of the surfaces in view of the test surface has on the coefficients determined. Heat dissipation from a surface is given by the formula,

$$f = \frac{H}{t_s - t_a} = \frac{W_r + W_{cv}}{t_s - t_a} \qquad (2)$$

$$= \frac{0.178 \times 10^{-8} E \left(T_s^4 - T_s'^4\right) + W_c \sqrt{\frac{v + 68.9}{68.9}}}{t_s - t_a} \qquad (3)$$

where

H = the heat transfer from the surface in Btu per square foot per hour for the actual temperature difference.

t_s = the temperature of the test surface.

t_a = the temperature of the air unaffected by the surface.

T_s = the temperature of the test surface in degrees absolute.

T_s' = the temperature of the surfaces in view of the test surface in degrees absolute.

W_r = heat dissipated from the surface by radiation in Btu per square foot per hour.

W_c = heat dissipated from the surface in still air by convection in Btu per square foot per hour.

W_{cv} = heat dissipated from the surface by convection for the wind velocity v in Btu per square foot per hour.

E = the emissivity of the surface.

Equation (3) may be written, $f =$

$$\frac{0.178 \times 10^{-8} E \left(T_s^4 - T_a^4 \right)}{t_s - t_a} + \frac{W_c \sqrt{\frac{v + 68.9}{68.9}}}{t_s - t_a} \quad (4)$$

The first term of this equation expresses the rate of heat dissipation by radiation. For the condition of the tests here reported the test surface was maintained at 90 F and the duct wall surfaces in view of the test surface were maintained at 70 F, plus or minus 1 deg. Assuming a value of 1 for E, the value of the radiation term in equation (4) becomes

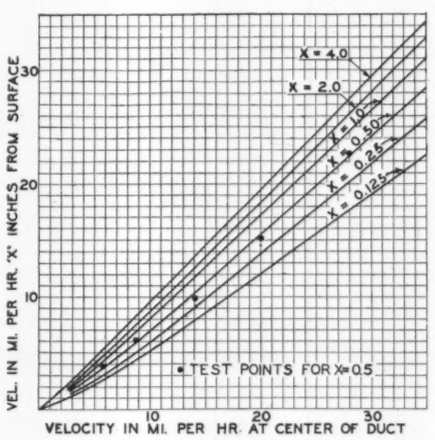


FIG. 12—RELATION BETWEEN VELOCITY AT CENTER OF DUCT AND VELOCITY AT POINTS DISTANT X FROM THE SURFACE FOR A 12-IN. DUCT

$$\frac{0.178 \times 10^{-8} (90^4 - 70^4)}{90 - 70} = \frac{22.41}{20} = 1.1205$$

If the temperature of the surrounding wall surfaces fell by 10 deg without any change in the air temperature the value of the term would become,

$$\frac{0.178 \times 10^{-8} (90^4 - 60^4)}{90 - 70} = \frac{32.75}{20} = 1.6337$$

A small error in the temperature of the surrounding surfaces would, therefore, make an insignificant error in the value of f.

Curves in Fig. 2 for the smooth pine surface in the 6-in. and the 12-in. ducts indicate a higher rate of heat transfer for the same wind velocity in the center of the smaller duct. This may result from a steeper temperature gradient and therefore a lower air temperature near the true surface, or it may result from a steeper wind velocity gradient near the true surface. It is probable that both of these factors operate simultaneously to increase the rate of heat transfer from the surface in smaller ducts for the same wind velocity at the center. It is axiomatic that a steeper wind velocity gradient near the surface will automatically result in a steeper temperature gradient. Temperature gradient curves for wind velocities of 1, 5, and 34 mph in the 12-in. duct are plotted in Fig. 15. These curves show steeper temperature gradients near the surface in the same duct for the higher wind velocities. Comparison of the curves for a 34-mph wind in the two ducts shows that the same wind velocity in the smaller duct is accompanied by a steeper

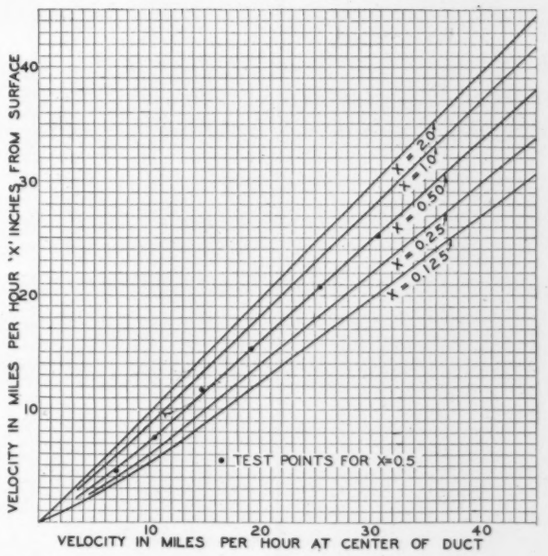


FIG. 13—RELATION BETWEEN VELOCITY AT CENTER OF DUCT AND VELOCITY AT POINTS DISTANT X FROM THE SURFACE FOR A 6-IN. DUCT

temperature gradient. Wind velocity gradients near the surface are also shown for a wind velocity of 34 mph in the center of the 6-in. and 12-in. ducts and in free space.

It is of particular interest to note how near the warm surface the temperature of the air becomes constant and unaffected by the surface. Except for velocities under 5 mph the temperature gradient does not extend appreciably beyond 1 in. and for velocities as low as 1 mph the gradient does not extend beyond 1½ in. from the surface. These curves indicate that for these con-

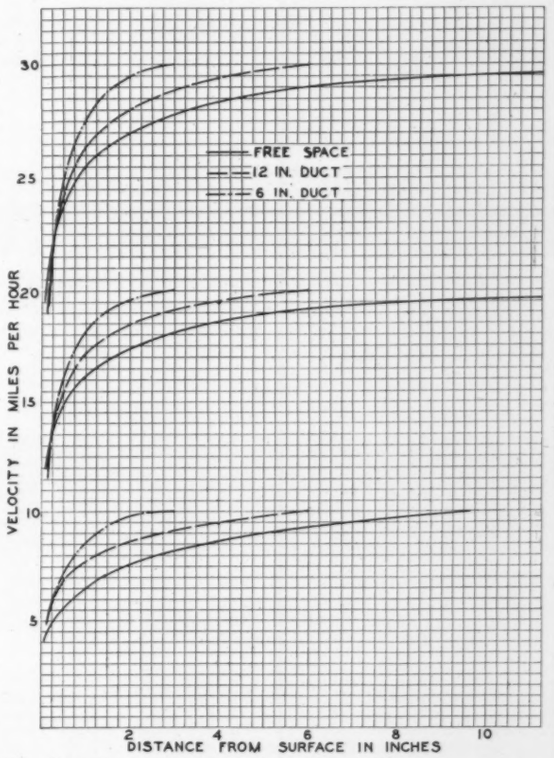


FIG. 14—VELOCITY GRADIENTS FOR A SURFACE IN FREE SPACE IN A 12-IN. DUCT AND IN A 6-IN. DUCT FOR WIND VELOCITIES OF 10, 20 AND 30 MPH

ditions an air temperature determined 1½ in. or more away from the surface is sufficiently accurate and unaffected by the surface for use in calculating heat transfer coefficients.

The National Advisory Committee for Aeronautics developed the following equation for velocity gradient curves resulting from their studies:

$$\frac{V_x}{V_c} = \left(\frac{X}{C}\right)^{\frac{1}{z}} \qquad (5)$$

where

V_c = the velocity at sufficient distance from the surface to be unaffected by it.

V_x = the velocity at a point X distance from the wall surface.

C = the distance from the wall to the nearest point having velocity V_c.

z = a constant to be evaluated.

Their work does not indicate any change in C and z with change in velocity. In the study here reported, the

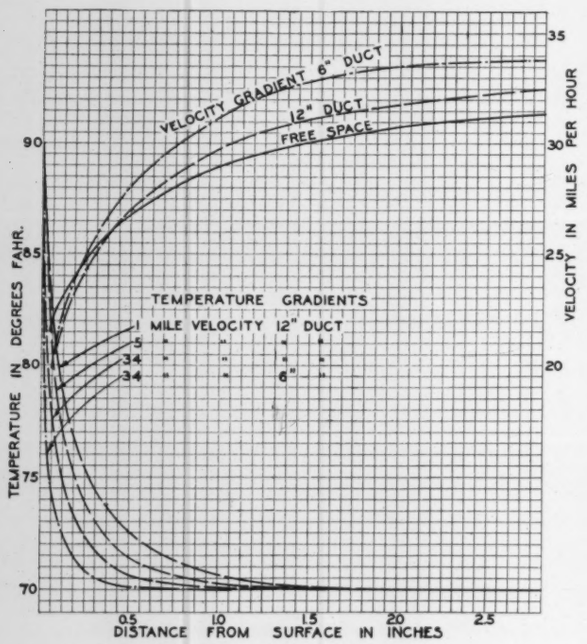


FIG. 15—TEMPERATURE GRADIENTS FOR WIND VELOCITIES OF 1, 5 AND 34 MPH IN A 12-IN. DUCT AND 34 MPH IN A 6-IN. DUCT. VELOCITY GRADIENTS FOR A 34-MPH WIND IN THE TWO DUCTS AND IN FREE SPACE

formula given could not be made to fit the velocity gradient curves for free space unless C and z were given values which varied with the velocity V_c. By giving C and z the variable values shown by the curves so marked in Fig. 10, the family of gradient curves shown by broken lines were obtained. While this series of curves does not fit the experimental data as well as the solid line curves, the discrepancy is not very great.

The velocity gradient curves for free space indicate that a constant velocity is reached 10.2 in. from the wall for a 10-mph wind and 13.9 in. from the wall for a 50 mph wind. However, the change in velocity beyond 6 in. becomes comparatively small. The error in observing a 10-mph wind 6 in. from the surface is only 0.5 mph while the error in observing a 50 mph wind 6 in. from the wall is 1.0 mph.

The three families of wind velocity gradient curves for free space, 12-in. duct, and 6-in. duct, as plotted in Fig. 14 show clearly that any given velocity measured in the center of the duct shows a steeper gradient for the smaller duct while a less steep gradient is found near the surface for the same velocity in free space. The steeper velocity gradients near the surface of the smaller duct account for the steeper temperature gradient. They also account for the higher film conductance curve for the same velocity at the center of the smaller duct.

It is probable that an equation expressing accurately the true velocity gradient curve near a surface, together with the air temperature in the free unobstructed space, and the temperature of the surface, would prove sufficient to determine accurately the rate of heat transfer. The methods available for making the necessary measurement of wind velocities for developing the wind velocity gradient curves and their equations are, however, not sufficiently accurate for this purpose, largely due to inability to properly evaluate the true effective distance between the Pitot tube dynamic orifice and the surface and also due to the disturbing effect which the close proximity of the Pitot tube and the wall have on the wind velocity at this point.

A study of the wind velocity gradients for the 6-in. and 12-in. ducts in Fig. 14 in comparison with the film conductance curves for the smooth pine surface in the 6-in. and 12-in. ducts, Fig. 2, will give some indication of the relation between the distance from the surface at which the wind velocity is measured and the film conductance coefficient obtained.

Wind velocities of 10, 20, and 30 mph as measured in the center of the 12-in. duct give velocities of 9.1, 19.1, and 28.9 mph respectively measured at 3 in. from the surface. The ratios of the velocities at the center of the 6 in. duct to the respective velocities measured at the same distance, or 3 in., from the surface in the 12 in. duct are as follows:

$$\frac{10}{9.1} = 1.099; \quad \frac{20}{19.1} = 1.044; \quad \frac{30}{28.9} = 1.039.$$

For these same wind velocities the ratios of the film conductance coefficients measured in the 6-in. duct to the respective film conductance coefficients measured in the 12-in. duct compare closely with the velocity ratios and are as follows:

$$\text{For a 10-mph velocity } \frac{5.25}{4.81} = 1.091$$

$$\text{For a 20-mph velocity } \frac{8.50}{7.75} = 1.098$$

$$\text{For a 30-mph velocity } \frac{11.20}{10.25} = 1.092$$

If it may be assumed that the same relationship holds for other sizes of ducts and for free space, then the coefficients for any velocity as measured at the center of different ducts may be expressed as proportional to the velocity in that duct measured at 3 in. from the surface. Coefficients for a smooth pine surface and a 20 mph wind measured in a 6-in. and a 12-in. duct and in free space would vary as the respective velocities measured at 3 in. from the surface or as 20, 19.1 and 18.1. Based upon a coefficient of 8.5 determined in the 6-in. duct, the coefficients measured in a 12-in. duct and in free space should be 8.1 and 7.7 respectively. The value of the coefficient measured in the 12-in. duct was 7.75. Hence the

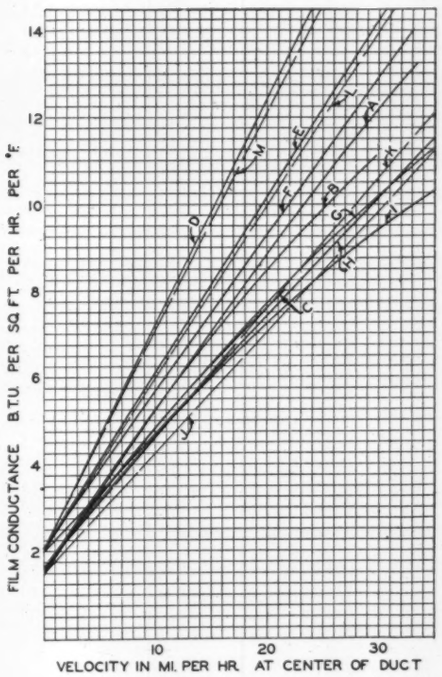


FIG. 16—FILM CONDUCTANCE COEFFICIENTS FOR STILL AND MOVING AIR AS DETERMINED IN THIS STUDY AND REPORTED BY ROWLEY AND OTHERS[a]

[a] Curve *A* Sanded Surface ..... This Report
B Smooth Pine (6-in. duct) ..... This Report
C Smooth Pine (12-in. duct) ..... This Report
D Stucco ..... Rowley, Algren and Blackshaw
E Brick and Rough Plaster .... Rowley, Algren and Blackshaw
F Cast Concrete ..... Rowley, Algren and Blackshaw
G Smooth Pine ..... Rowley, Algren and Blackshaw
H Smooth Plaster ..... Rowley, Algren and Blackshaw
I Glass and White Gloss Paint .. Rowley, Algren and Blackshaw
J $f = 1.4 + 0.281V$
K $f = 1.6 + 0.3V$
L $f = 2.0 + 0.4V$
M $f = 2.1 + 0.5V$

application of the foregoing reasoning gives a fair approximation.

The curves indicating the relation between film-conductance coefficient and wind velocity developed at the laboratory and presented in Fig. 2 of this paper are shown in Fig. 16 together with similar curves reported by Rowley, Algren and Blackshaw [5] for an 80-F mean temperature. Both investigations give data for a smooth finish white pine surface. The values in this report giving curves for the 6-in. and the 12-in. ducts were determined with a 20-deg. temperature difference and an 80-F mean temperature. Both reports include data determined in a 6-in. duct with an 80-F mean temperature which should check. It is observed, however, that the Laboratory curve *C* for an 80-F mean temperature determined in a 12-in. duct coincides with Rowley's curves *G* for an 80-F mean temperature determined in a 6-in. duct. This discrepancy is somewhat larger than the possible experimental error but may be accounted for by the difference in pine surfaces studied.

The entire group of curves show a marked similarity. All the materials included in the two studies show still-air film-conductance coefficients ranging from 1.4 to 2.1. All the curves plotted against wind velocity show a similar tendency. The smoother surfaces show a lower coefficient for the same wind velocity and a slight curvature.

For wind velocities up to 35 mph, a straight line would approximate any of the curves to a fair degree of accuracy. The curve *J* approximating the lower limit of the entire series gives a relationship between film conductance and wind velocity satisfied by the equation $f = 1.4 + 0.281v$, where v is the wind velocity. The curve *D* for stucco is satisfied by the equation $f = 2.1 + 0.515v$. For a rough approximation, the curves *K*, *L*, and *M* having the following simple equations could be accepted as representing the following general types of surfaces: For curve *K*, representing smooth wood and plaster, $f = 1.6 + 0.3v$. For curve *L* representing cast concrete surfaces and fairly smooth brick surfaces, $f = 2 + 0.4v$. For curve *M*, representing rough stucco and other similarly rough surfaces $f = 2.1 + 0.5v$.

The several curves for the different surfaces studied in the two investigations indicate rather clearly that roughness of surface is the main factor affecting film conductance coefficients for any type of material used in building construction. A further study and gradation of surfaces with respect to roughness should therefore make possible the acceptance of a film conductance coefficient for new types of surfaces without the necessity of actually testing them. In the meantime, the rough approximation of the surfaces for which curves and formulae are given may be of some practical value.

Summary and Conclusions

1. This report presents wind velocity gradient curves away from a wall in free space and away from the surface of rectangular ducts which are 6 in. and 12 in. in width. Film conductance coefficients for still and moving air for a sanded surface in a 12-in. duct and for a smooth pine surface in both a 6-in. and a 12-in. duct are also presented.

2. Wind velocity gradients for free space extend to distances of 10.2, 13.2, and 13.7 in. from the wall for velocities of 10, 20, and 30 mph, respectively.

3. For the same velocity in the center of rectangular ducts of different sizes the gradient is steepest near the surface of the smaller duct. This is accompanied by a steeper temperature gradient and a higher film conductance.

4. Temperature gradients are shown to vary with the size of the duct and the wind velocity. For a 20-deg temperature difference and velocities of 5 mph and higher, the temperature gradient lies within 1 in. of the surfaces. For velocities down to 1 mph, the gradients extend to as far as 1½ in. from the surface.

5. Film conductances for a number of surfaces reported here and elsewhere are shown to vary between 1.4 and 2.1 for still air and between the limits of the simple equations:

$$f = 1.4 + 0.281v$$
and $$f = 2.1 + 0.515v$$
where v = the velocity in miles per hour.

Film conductance is largely a function of roughness for the surfaces considered and can probably be expressed from a gradation of roughness of surfaces. A rough approximation of such a gradation and the equation for the coefficients are presented.

[5] *Surface Conductances as Affected by Air Velocity, Temperature and Character of Surface*, by F. B. Rowley, A. B. Algren, and J. L. Blackshaw [A. S. H. V. E. JOURNAL SECTION (HEATING, PIPING AND AIR CONDITIONING), June, 1930].

Proceedings of the 37th Annual Meeting

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Pittsburgh, Pa., January 26 to 29, 1931

A RECORD was set at the 37th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, held at the William Penn Hotel, Pittsburgh, Pa., January 26-29, 1931, when the attendance surpassed any meeting, except that in Philadelphia in 1930 which was stimulated by the interest in the first Heating and Ventilating Exposition.

The Pittsburgh meeting was outstanding not only with its attendance of 620, but also because of the number of papers and reports presented, and the unique features of entertainment.

The highest praise is due the local committee of the Pittsburgh Chapter for the efficient manner in which they handled the details of the meeting, and for the excellent entertainment program sponsored by them. The Committee on Arrangements included H. Lee Moore, *General Chairman;* H. B. Orr, *Chairman,* Reception Committee; F. C. Houghten, *Chairman,* Program Committee; R. B. Stanger, *Chairman,* Entertainment Committee; F. A. Gunther, *Chairman,* Banquet Committee; W. W. Stevenson, *Chairman,* Transportation Committee; J. E. McGinness, *Chairman,* Publicity Committee, and F. C. McIntosh, *Chairman,* Finance Committee.

The technical program was particularly outstanding, not only because of the quality of the papers presented, but also because of the variety of subjects covered and the unusually large number of papers given. A total of 22 papers was presented, in addition to two codes, one code dealing with concealed radiation and the other with oil burning devices.

First Session—Monday, January 26—2:00 P.M.

The 37th Annual Meeting was called to order by Pres. L. A. Harding, and F. C. Houghten, president of the Pittsburgh Chapter delivered the address of welcome to the members and guests attending the meeting.

D. J. Howard, of the Pittsburgh Chamber of Commerce, extended greetings from the City of Pittsburgh and said that although Pittsburgh is a great industrial city and is usually thought of solely as such, it also has an extraordinary aesthetic side to it, as there are three large universities in the city. He also stated that Pittsburgh has the greatest art center in the world, which is located at Carnegie Institute, and which has an International Art Exhibit every year. Mr. Howard also referred to the accomplishments of Pittsburgh along the lines of smoke abatement.

H. Lee Moore, chairman of the Committee on Arrangements for the Pittsburgh Chapter, expressed his appreciation for the large attendance and gave details of the entertainment program.

The Report of the Council was read by Secretary A. V. Hutchinson, and was adopted as read.

Report of the Council

The 1930 Council was organized in Philadelphia, Pa., on January 31 and during the past year has held seven meetings—two in New York City and one each in Philadelphia, Toronto, Minneapolis, Buffalo and Pittsburgh.

In compliance with the provisions of the Constitution and By-Laws, the Council appointed its standing committees: *Executive,* W. H. Carrier, Chairman; *Membership,* J. D. Cassell, Chairman; *Publication,* G. L. Larson, Chairman; and *Finance,* F. C. McIntosh, Chairman, and during the year, as occasion demanded, appointed special and continuing committees as follows: *Guide Publication Committee,* D. S. Boyden, Chairman; *Committee on Increase of Membership,* C. W. Farrar, Chairman; *Committee on Rules of Award for F. Paul Anderson Medal,* F. C. McIntosh, Chairman; *Committee on Chapter Relations,* R. H. Carpenter, Chairman; *Committee on Revision of Constitution,* Thornton Lewis, Chairman; *Committee on Definition of Heating Terms,* A. C. Willard, Chairman; *Committee on Code for Testing and Rating Gravity Type Concealed Radiation,* R. N. Trane, Chairman; *Committee on Testing and Rating Unit Ventilators,* John Howatt, Chairman; *Committee on Testing and Rating Unit Heaters,* D. E. French, Chairman; *Committee on Revision of Code of Minimum Requirements for Heating and Ventilation of Buildings,* Perry West, Chairman; *Committee on Air Conditioning Standards,* Dr. E. V. Hill, Chairman.

At the April 2 meeting the budget of the Finance Committee was approved, which provided for an income from SOCIETY activities of $49,100 and an expenditure of $40,550 and $6,000 additional for an executive secretary of the Committee on Research, also a Guide Budget of $48,500 income and $39,900 expenditure. Both exceeded expectations. Depositories for SOCIETY funds were selected and the Endowment Fund of the SOCIETY was placed in a custodian account at the Bankers Trust Co., and the interest from this fund is to be used for research.

Dates for the Semi-Annual Meeting 1931, June 23-26, were selected and at the invitation of the Massachusetts Chapter, the meeting will be held in Swampscott. The 38th Annual Meeting is to be held January 25-29, 1932, in Cleveland, Ohio, under the direction of the Cleveland Chapter members and at the same time as the Heating and Ventilating Exposition.

Petition for a charter for a Southern California Chapter was received and acted upon favorably and the new chapter made an auspicious start with a membership of 60.

At a joint meeting with the Committee on Research the question of establishing the SOCIETY'S Research Laboratory in Buffalo in buildings offered to the SOCIETY was discussed, but it was found inadvisable to move from the present location in the Bureau of Mines Pittsburgh Experiment Station.

The Council approved the *American Standards Association* Safety Code on Mechanical Refrigeration and authorized the printing and distribution, to members for discussion, of the newly prepared Codes for Testing Steam Heating Boilers Burning Oil Fuel and the Testing and Rating of Concealed Gravity Type Radiation.

The presentation of a complete set of Society Transactions to the Bureau of Mines, Pittsburgh Experiment Station, was authorized and a portrait of Benjamin Franklin, the SOCIETY'S patron saint, was purchased for the headquarters office.

At the December meeting, the Council nominated candidates

for the Research Committee as required by the Constitution and By-Laws.

Various routine actions were taken in reference to membership with the acceptance of resignations, cancellation of membership for non-payment of dues, and reinstatements. Life Membership was conferred upon the following men during the year: Henry B. Gombers, George F. Stone and Prof. L. P. Breckenridge.

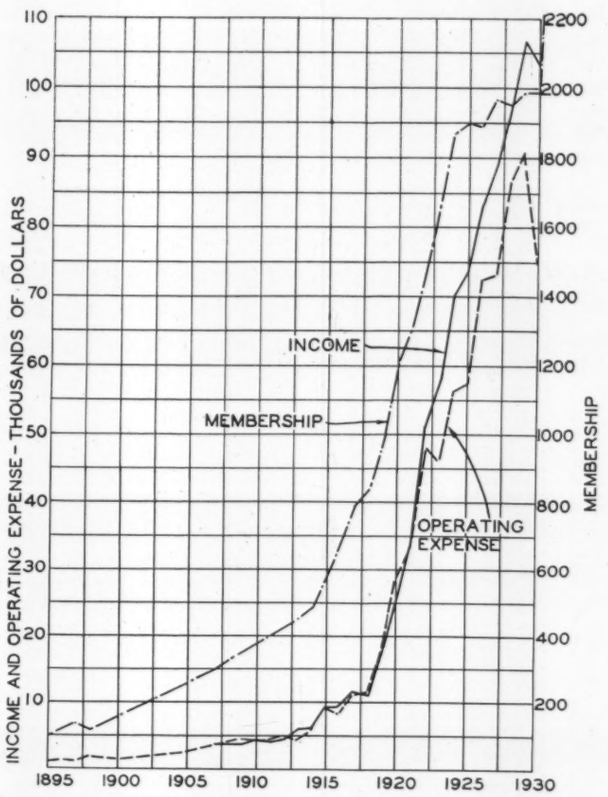
At the concluding meeting of the Council on January 26, approval of a plan to have joint sessions with the *American Society of Refrigerating Engineers* at Cleveland was voted.

Respectfully submitted,

THE COUNCIL

Report of the Secretary

Several significant points are to be noted in a review of the Society activities for 1930: *First,* the A. S. H. V. E. Research Laboratory has successfully completed 10 years of service to the profession and industry and it is fitting that the Society should meet in Pittsburgh and hold a technical session of the Annual



Meeting at the Laboratory in the U. S. Bureau of Mines Building.

Second, THE GUIDE commences its 10th year of existence and the next volume, the 1932 edition, will be the anniversary number of this important book which has made heating and ventilating history.

Third, the first year having the SOCIETY'S JOURNAL as a part of *Heating, Piping and Air Conditioning,* was completed in May, 1930, with evident satisfaction to a majority of the membership.

In a glance backward over the progress of the SOCIETY since its organization in 1895, the appended chart showing income, expenditures and membership status, will be of particular interest as it reveals a steady growth of the organization.

During the year 1930, 354 new members were added to the roll of membership and the total number now on the roster is 2224. It will be noticed that the SOCIETY income is increased in greater proportion than the membership, due to the large income from the JOURNAL and GUIDE.

An opportunity for rendering an extra service to the membership came this year and continued effort has been made to arrange for employment for those who needed such service.

A new location was found for the headquarters office in the New York Life Insurance Building when it was found necessary to leave the Engineering Societies' Building and every member who has visited the new offices, has found much to praise in the action of the Executive Committee in choosing the location and furnishing the new quarters.

A closer relationship with the Chapters was established by having the National Officers give one program at each Chapter during the season. President Harding, Treasurer Farrar, Director Houghten, of the Research Laboratory, and the Secretary of the SOCIETY, visited the majority of Chapters together, and the talks given covered matters of general and technical interest as well as a comprehensive statement on the SOCIETY activities. The Secretary enjoyed the privilege of visiting each of the 15 Chapters and in October attended the organization ceremonies of the new Southern California Chapter.

All of the Council Committees have been exceedingly active during the ye · and heavy burdens have fallen on several of the special c · .tees, notably the Guide Publication Committee, the Committee n Ventilation Standards and the committees developing the oncealed Radiator Code and the Testing Code for Boilers using Oil Fuel. The individual reports of the various committees will indicate the work that has been under way and a forecast for future activities.

Two copies of the TRANSACTIONS have been prepared and printed during the past year, the 1928 volume having been mailed and the 1929 edition now being prepared for mailing.

All routine business required by the Constitution and By-Laws has been carried out by the Secretary's office and the activities during 1930 have been of larger volume than in any previous year. The work was carried through without additional assistance and much credit is due the staff for the fine cooperation that has been given.

The year 1931 is anticipated with considerable pleasure as it is believed that the SOCIETY will maintain its growth and add to its prestige by attracting the attention and interest of a larger number of the leading engineers who will desire to be identified with an organization which pays such a fine return on the investment.

Respectfully submitted,

A. V. HUTCHINSON, Sec'y.

In a characteristic and appropriate speech, John D. Cassell, Philadelphia, unveiled a portrait of the Society's patron saint, Benjamin Franklin, recently obtained by the Council for the headquarters office of the Society.

The first paper on the program was that entitled Progress in Heating and Ventilating During the Past Quarter of a Century, by R. P. Bolton, which was delivered by the author, 20th President of the Society. Mr. Bolton gave a very interesting abstract of the subject matter covered in the paper. (The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, January, 1931, p. 47.)

Developments in Heating and Ventilating During 1930, by S. R. Lewis, another Past President of the Society, was the next paper on the program and was presented in abstract by A. G. Sutcliffe, president of the Illinois Chapter. At the May, 1930, meeting of the Council, Pres. L. A. Harding proposed that a record of the progress of heating and ventilating during the year be made an annual feature of the Society's Transactions. Acting upon this suggestion, the Council

invited Mr. Lewis to undertake the preparation of a paper covering the year 1930, and he handled this difficult assignment in a most effective manner.

The next paper on the program was that entitled Heat Emission from the Surfaces of Cast Iron and Copper Cylinders Heated with Low Pressure Steam, by A. C. Willard and A. P. Kratz, and was presented by Professor Willard. (The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, February, 1931, p. 141.) In this paper the authors endeavored to explain why a cast-iron cylinder with walls 0.25 in. thick will transmit over 50 per cent more heat than a copper cylinder of exactly the same size with walls 0.01264 in. thick, when there is low pressure steam inside of the cylinder and air on the outside. It was specifically pointed out in the paper that the surface finish is an all-important factor in the heat emission from metal cylinders filled with saturated steam and surrounded with air. After presentation of the paper by Professor Willard, additional comments on the subject were made by Professor Kratz.

In discussing this paper, F. C. Houghten stated that it filled a great need, judging from the inquiries received by the Society's Research Laboratory regarding the relative heat emission from various surfaces. Mr. Houghten inquired as to whether the authors could give any data on the relative heat emission from smaller cylinders of the magnitude of pipe, particularly pipe an inch and a quarter in diameter and less. Professor Willard stated that no tests had been made on smaller or larger cylinders, and Professor Kratz added that the available theoretical data can be used to take into consideration smaller or larger surfaces in various positions, and also flat surfaces.

L. W. Schad pointed out that the diameter of the cylinder would, no doubt, influence the convection, and that convection differences would disappear as the diameter decreased. Mr. Schad inquired as to whether the authors had experimented with metallic paints which would decrease the radiation from cast-iron cylinders, to which Professor Willard replied that they had. It was stated that rusty sheet-iron drums were painted with aluminum paint, and a very material reduction in the heat emission was obtained when the character of the surface was changed.

Percy Nicholls questioned whether the authors were justified in assuming that the computed convection was correct, since in his opinion convection from the comparatively short cylinder might be subject to considerable error. Mr. Nicholls stated that the emissivity value obtained for polished copper surfaces was much higher than it should have been. Professor Willard replied that what Mr. Nicholls said was true, but that the surfaces used were commercial copper surfaces as received. Whether higher emissivity values could have been obtained by polishing the surfaces to a greater extent, Professor Willard said was debatable, but admitted it to be a possibility.

Professor Willard also called attention to the fact that it was not intended that these tests be conducted to a high degree of refinement, since the primary object was to lay before the manufacturers and the users of cast-iron and other metallic tubes and cylinders the basic conception that wall thickness does not necessarily indicate the relative amount of heat that will be transmitted, but that within certain limits the surface finish does determine how much heat will be transmitted.

W. H. Carrier brought up a question in regard to the calculated and tested heat losses by convection and radiation, which was answered by Professor Willard.

R. V. Frost related some of the results of experiments conducted at his laboratory on various metals, and stated that from the standpoint of heat emission the best results were obtained with steel, and expressed the opinion that this metal was worthy of consideration in the manufacture of fin-type radiation.

Mr. Carrier, however, thought that Mr. Frost had neglected an important economic aspect. He pointed out that when the velocities are increased, a very different relationship is obtained, and that the resistance of the heater must be taken into consideration. He also related in some detail experiments made by his organization in connection with the use of iron fins, and the comparative results obtained.

R. C. Bolsinger expressed the opinion that the paper had gone a long way toward clearing up some of the existing misconceptions. He also called attention to the fact that the surfaces tested were cylindrical and the results obtained might or might not apply in the same way to commercial radiators of different types. Professor Willard endorsed what Mr. Bolsinger had said, but emphasized that the principle involved is the same regardless of the shape, namely, that the surface coating affects the heat emission by radiation.

Heating Effect of Radiators, by R. V. Frost, was the next paper on the program. (The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, February, 1931, p. 168.) This paper was based on experiments conducted by the author, who pointed out that in arriving at the conclusions submitted the effect due to radiation loss should not be confused with the improved air distribution in the room. He stated that the tests not only demonstrate that the cabinet over the radiator prevents the loss of a large percentage of radiant heat, but that it also distributes it at a lower level.

After the presentation of the paper, a written discussion was read by Professor Willard, in which he pointed out that there was a very much higher condensation rate in the cast-iron radiator during the first half hour, which Mr. Frost explained was due to the heat capacity of the radiator. He stated that this was a practical demonstration of the necessity for a heating-up factor in figuring the load on a boiler. He also stated that the heating-up factor for cast-iron radiation is much higher than for the fin-type radiator. Mr. Frost agreed that the results shown were incomplete, but stated that it would take some time to completely cover the subject because of the magnitude of the work involved.

D. E. French expressed his appreciation of the paper, and stated that it would be of especial value as a guide to the test work that must still be done. Mr. French pointed out that the results reported in this paper apply accurately only to the actual radiators tested, and that if the various positions had been changed the results might be somewhat different. He offered suggestions for further study on this subject, and then questioned the statement made by Mr. Frost to the effect that if the room were completely insulated to prevent all loss of

radiant heat, the heating effect of the exposed radiator would then be equal to that of the cabinet radiator.

E. K. Campbell emphasized the statement that had already been made to the effect that the enclosed radiator transfers radiant heat into convected heat, thereby increasing the volume of air moved and lowering the temperature of the air. He stated that the question of how much air a direct radiator moves had been brought up several years ago and that there seemed to be no data available at that time, nor are there any available now. He reiterated that it is entirely a question of changing radiant heat into convected heat, thereby increasing the volume of air moved and lowering the temperature.

R. C. Bolsinger expressed a desire to have the experiments continued using radiators of different sizes and shapes, particularly much lower and narrower radiators, where the flue effect would be considerably less. He ventured the opinion that radiators of this type would lower the temperature differential between floor and ceiling.

W. H. Carrier stated that he was very much interested in this subject, not so much from the standpoint of the kind of radiators to be used as from the standpoint of what should constitute comfort in heating a building. He expressed the opinion that it was not as important to save a certain percentage of the steam as it was to maintain uniform temperature conditions, and called attention to instances where, owing to the construction of a building, our heads would seem almost in a fever and yet our feet would be cold. He emphasized the fact that comfort is the primary consideration, and that economy is secondary, although, of course, both are important. Mr. Carrier also called attention to the desirability of taking temperature readings with a thermometer having a blackened bulb in order to obtain the temperature that the body feels. He cautioned that if air temperatures were solely considered, the results might be misleading, and that radiation from the surfaces of walls and windows is just as essential, in considering the problem, as room temperatures.

E. R. Queer stated that one point that had been brought up might be misleading, namely, that radiation effect from radiators is not desirable from the standpoint of good temperature distribution. He called attention to the results of experimental work of Prof. A. C. Willard and M. K. Fahnestock.

Mr. Frost replied briefly to the discussion and stated that experimental work must be carried on for some time in order to obtain complete results.

The Report of the Tellers of Election was submitted by S. E. Dibble, chairman, as follows:

Report of Tellers of Election

The undersigned Tellers report that they have counted and checked all ballots cast and find the following to be a true count:

OFFICERS—

President—W. H. Carrier 654
First Vice President—F. B. Rowley 653
Second Vice President—W. T. Jones 653
Treasurer—F. D. Mensing 654
Members of Council—Three Year Term:
E. K. Campbell 655
E. O. Eastwood 655
R. Farnham 654
E. H. Gurney 655
Council—Two Year Term:
D. S. Boyden 655
Void Ballots 3
Members of Committee on Research:
C. A. Booth 642
F. B. Howell 641
Walter Klie 643
F. B. Rowley 643
J. H. Walker 644
Void Ballots 2
Total ballots cast not signed 11
Total ballots cast by members in arrears of dues 20

Respectfully submitted,
S. E. Dibble, *Chairman;*
Alfred J. Offner,
F. H. Morris.

The Report of the Committee on Code for Testing and Rating Concealed Gravity Type Radiation was submitted by R. N. Trane, chairman, who explained in detail the principles of the code and the ideas of his committee, consisting of E. H. Beling, W. F. Goodnow, Hugo Hutzel, A. P. Kratz, E. J. Vermere and O. G. Wendel. A preliminary draft of this code was sent to members of the Society to be used as a basis of discussion. Mr. Trane related some of the experiences of the committee in developing the code, and stated that this preliminary draft could not be considered final, but represented what was believed to be the best available information.

In answer to the question of D. E. French, Mr. Trane advised that sun effect on the test booth was to be eliminated as far as possible.

A. B. Arnold offered three suggestions with respect to paragraphs 13, 16 and 21. D. E. French was in agreement with Mr. Arnold relative to insulation of piping, and he further stated that laboratory results indicated the accuracy of the exponential equation referred to in Section 25. Additional comments were offered by W. H. Carrier and J. F. McIntire.

Mr. Trane then presented the second section of the code dealing with radiators using hot water, and the discussion which followed was given by Thornton Lewis, F. D. Mensing, J. F. McIntire and R. V. Frost.

After a lively parliamentary discussion in reference to making the code available for use, by Messrs. French, Mensing, Fleisher, Rowe, McIntire and Holton, the following resolution was offered by Mr. Rowe, seconded by Mr. McIntire, and adopted:

That the Society recommend the use of the steam section of the Report of the Committee on the Proposed Code for Testing and Rating Concealed Gravity Radiation, and that the suggestions developed in this meeting be referred to the committee and incorporated in its report at the next meeting of the Society.

Second Session—Tuesday, January 27—9:30 A. M.

President Harding opened the second session and announced the presentation of the paper entitled Development of the Ventilation System of the Holland Tunnel, by A. C. Davis, which was given in abstract by the author with the aid of slides. (The complete paper was

published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, October, 1930, p. 866.)

Many written discussions regarding this paper were received, indicating exceptional interest in the subject.

Professor Willard, who was identified with the experimental work upon which the ventilation of this tunnel was based, extolled the work of C. M. Holland, the first chief engineer; Ole Singstadt, the present chief operating engineer, and Mr. Davis. He explained that the experiments at the University of Illinois dealt particularly with the power requirements of the tunnel, and stated that Mr. Davis represented Mr. Holland at the University throughout the period of five or six years, during which the studies were made.

One problem, he stated, was to ascertain how much power it took to get the air into the tunnel, and the other problem was to find out how much power it took to get it off the roadway. It would appear that the power requirements would be about the same, but it was found that the exhaust power requirements were about two and a half times the supply power requirements, due to the fact that the jet of air across the main stream of air acted as an air screen, or as an air baffle. By changing the design it was possible to reduce the power requirements for the exhaust side to practically the same as the inlet side. Professor Willard stated that the tunnel might have been a complete failure had these facts not been available prior to the construction of it. He stated that the frictional equations for the supply and exhaust ducts were developed by the late Prof. G. A. Goodenough of the University of Illinois, who took the experimental data for all sizes of models, for all lengths of ducts, for all conditions of air flow and reduced these data to the two fundamental flow equations in the paper.

Dr. R. R. Sayers of the Bureau of Mines also spoke at length on this subject and told of his experiences in connection with the development of the tunnel. He told of some experiments in determining the effect of carbon monoxide on those who were stationed in the tunnel. One of the by-products of the study of the ventilation requirements of the Holland Tunnel was the development of an instrument that would analyze the air and record the amount of carbon monoxide at all times. There are fourteen of these instruments installed in the tunnel, and they also indicate when fires take place.

In closing the discussion, Mr. Davis revealed some very interesting facts concerning the operation of the tunnel. He stated that in the three years the tunnel has been operating, they found that patrolmen had suffered no ill effects, although a physician has been continually watching this condition and making blood analyses. The main difficulty seems to be the monotony of the duties. Mr. Davis explained how the carbon monoxide content is watched and how precautions are taken to prevent the amount of this gas from exceeding the allowable quantity. His discussion of the problem of fires in the tunnel was especially interesting.

Following Mr. Davis' paper, three papers dealing with various phases of the noise problem were presented. The first of these was Noise Reduction in Ventilating Units, by Warren Ewald, which was presented in abstract by the author. (The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, November, 1930, p. 968.)

In a written discussion of this paper by John Howatt, he stated that there is no class of equipment in which it is more essential that noise be eliminated than in unit ventilators. He expressed the opinion that this is one of the major obstacles which makers of this class of equipment must overcome before they will be completely successful in their best field, namely, that of school room ventilation. He also said that almost any well constructed machine could be made to run quietly on test when it is new, but it may not be so quiet in operation two years later.

W. A. Rowe commented on that portion of the paper dealing with the sources of sound. Mr. Rowe pointed out that a great deal of the trouble experienced is due to the fact that obstructions are installed in a system which provide a greater degree of resistance than the equipment was intended to provide for. He related an experience which had come to his attention recently to indicate that fan noises are frequently due to resistances and obstructions not originally considered, and pleaded for more careful design and selection on the part of architects and engineers.

The paper Noise and Ventilation, by G. T. Stanton, was submitted in abstract by the author. (The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, December, 1930, p. 1049.) A written discussion by Albert Buenger, St. Paul, Minn., was read by Mr. Carrier, and A. E. Stacey also read a prepared discussion, emphasizing some of the points covered by Mr. Stanton, including the value of ventilation and air conditioning as a means of keeping out outside noises. Mr. Stacey suggested a specification for acceptable noise levels based on different types of systems in rooms intended for different uses.

Mr. Stanton replied that something of this sort might be possible, but that the most stringent cases in which air conditioning or ventilating systems are installed are those in which the management has determined from the physiological studies what the requirements may be. He referred to a specific case with which he was familiar in connection with a hospital which necessitated that the room be sealed up from outdoors, using double windows, double doors, double walls and air conditioning. In this case, he stated, it was not entirely a question of the noise created in the system, but it was a question of the noise transmission through the system and the standards therefore were very rigorous.

In a written discussion by J. C. Steinberg, it was suggested that the ventilating noise should be 15 decibels or more below the room noise level in order to be inaudible. In reply to this statement, Mr. Stanton stated that room noise levels below 15 decibels are very special conditions, and in general exist only in the most carefully constructed laboratories.

At the conclusion of this paper, President Harding called upon several past presidents who were in the audience. John Hale stated that it was interesting to note that at the Semi-Annual Meeting of 1919 held in this room, the first real report of a research committee was made. H. M. Hart stated that he was happy to be a member of the Society, and that it was gaining more recognition every day. He also expressed a desire

to enjoy continued activity in the Society's affairs for a great many years.

J. R. McColl expressed his thanks, and Dean F. Paul Anderson offered the thought that the important consideration in reference to the future of the Society is the education of the young men who are taking up the work in this particular field. S. E. Dibble expressed pleasure at being a past president and to act as a host for the Society, and mentioned that the organization was making the heating and ventilating industry one of great importance.

When a man has served the Society to the extent that they have honored him by making him a President, W. H. Driscoll seemed to think that they had heard enough from him. He closed his remarks by telling a story. A. C. Willard related briefly his experiences with President Harding, and stated that Mr. Harding had been an inspiration to him ever since they met twenty years ago.

Thornton Lewis stated that he was delighted to see the constructive work being done by the Society, and mentioned that the influence of the Society is growing in proportion as the constructive work is growing.

H. B. Gombers, secretary-emeritus of the *Heating and Piping Contractors' National Association,* was invited to speak, and he related some very interesting experiences in connection with his membership in the Society, as well as the relationship between the two organizations.

George Ryan, New York, and P. F. Sullivan, Chicago, officially delegated by the *United Association of Journeymen Plumbers and Steam Fitters* of the United States and Canada to attend the meeting, explained that their organizations desired to acquaint the journeymen with the latest developments in research taking place in the heating and ventilating world.

The report of the Guide Publication Committee was submitted by D. S. Boyden, chairman, as follows:

Report of the 1931 Guide Publication Committee

THE GUIDE 1931 is now available. In order to maintain the leadership of the A. S. H. V. E. GUIDE as the accepted authority of the heating and ventilating profession, it is necessary to co-ordinate the results of the latest research with the practice of the outstanding engineers of the profession by recording the most up-to-date information and data available on each phase.

The editorial staff selected by the Guide Publication Committee, therefore, includes heating and ventilating engineers of unusual qualifications, who are specialists in the subjects to which they are invited to contribute.

The Guide Publication Committee is greatly indebted to the following engineers through whose efforts THE GUIDE 1931 has been made possible, and who have given their services without compensation or thought of reward other than the satisfaction of having performed a public service:

	W. G. Frank	
O. W. Armspach	S. McK. Gray	H. C. Murphy
W. S. Bondy	W. E. Heibel	Percy Nicholls
D. R. Brewster	R. H. Heilman	H. W. Pfeffer
J. C. Butler	F. C. Houghton	W. A. Rowe
A. C. Davis	H. B. Johns	G. K. Saurwein
T. J. Duffield	R. L. Jones	W. M. Sawdon
J. E. Emswiler	F. A. Kitchen	W. H. Severns
J. L. Faden	L. L. Lewis	Perry West
P. E. Fansler	E. A. May	H. M. Wylie

Some of the material from previous issues of THE GUIDE has, of course, been retained in THE GUIDE 1931. The Guide Publication Committee 1931 therefore acknowledges its debt to previous Guide Publication Committees and the editorial staffs associated with the committees for the foundation laid by these engineers.

To keep pace with the developments which have taken place in the heating and ventilating profession, three new chapters have been included in the 9th edition of THE GUIDE, and with but a single exception, all of the chapters have been revised or rewritten in the light of developments which have taken place since the publication of the 8th edition. There have been no deviations, however, from the fundamental principles upon which THE GUIDE was founded in 1922.

The subject of heat losses from buildings, formerly covered in one chapter, is treated in this issue of THE GUIDE in four separate chapters in a logical and concise manner. New data are included on infiltration losses, fan-furnace and fan steam heating systems, radiators and convectors, boilers and heaters, chimneys, solid and liquid fuels, electric heating, exhaust steam heating, district heating, automatic temperature and humidity control, pipe and pipe insulation, and pumps and traps. The subjects of ventilation standards and systems, air conditioning, ducts, registers and grilles, and fans and motive power have been greatly amplified and improved.

Research has played an important part in the preparation of THE GUIDE 1931. The results of investigations conducted at the A. S. H. V. E. Laboratory, operated in co-operation with the U. S. Bureau of Mines Station in Pittsburgh, and at the various institutions with which the Society maintains co-operative agreements, dominate the Technical Data Section throughout.

The Catalog Data Section has been carefully co-ordinated with the text, and contains supplementary information on specific materials, equipment and accessories available for heating and ventilating service. In the Catalog Section will be found sizes, shapes, capacities, dimensions, space requirements and applications so important to the engineer and contractor in planning, specifying and installing materials and equipment. The two sections are so interlocked that they are practically indispensable to each other, and for the best results it is recommended that the corresponding references in each section be consulted in all cases. The Catalog Data Section is dedicated to the presentation of reliable facts and figures concerning the products shown, eliminating as far as possible unnecessary "sales talk" and comparisons.

Total number of books printed	11,500
Total number of advertisers	203
New advertisers	46
Number of pages—Text Section	544
Number of pages—Advertising Section	360
Number of pages—Membership Section	60

Those manufacturers whose catalog data appear in THE GUIDE pay for the service rendered to them as effective advertising, and the support and co-operation of these manufacturers constitute an important part of the means whereby the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS is enabled to achieve the publication and wide distribution of THE GUIDE, and to extend its wholly philanthropic services to the general advancement of the profession and its allied industries. Engineering and manufacturing are dependent upon each other and both, jointly, are essential to the general interests of the public.

Of this 9th edition of THE GUIDE 1931, 11,500 copies have been published, and it is the hope of the Guide Publication Committee that this book will surpass in effective service the 1930 edition, of which over 10,300 copies were in use among the profession and the industry at large, as well as in schools where students have found it to be a reliable and practical text book.

The Committee has felt that the saturation point of usefulness of THE GUIDE might in the near future be reached, and in view of the present business depression the Committee was concerned as to the amount of advertising which might be secured.

The income from THE GUIDE 1931 was $52,374.31, with expenditures of $33,780.09, or a net balance of $18,594.22.

The above indicates that there is still an increasing demand for the yearly publication of THE GUIDE.

Attention is called to the fact that manufacturers during periods of depression increase advertising in an effort to stimulate sales, which fact is further evidence that THE GUIDE may continue indefinitely as a yearly publication.

THE GUIDE PUBLICATION COMMITTEE,
D. S. Boyden, *Chairman;*
V. S. Day,
R. V. Frost,
J. F. McIntire,
S. R. Lewis.

J. D. Cassell reported for the Membership Committee and stated that 354 new members had been secured during the past year, which he intimated was satisfactory in view of existing conditions.

Third Session—Tuesday, January 27—2:00 P. M.

The first paper presented at this session was that entitled Some Studies on the Absorption of Noise in Ventilating Ducts, by G. L. Larson and R. F. Norris, which was presented in abstract by Professor Norris. (The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, January, 1931, p. 59.)

In this paper the authors pointed out that quiet motors and fans should be specified, and that they should be mounted on special foundations designed for absorbing vibrations. It was also stated that fans should be connected to the duct system by means of canvas connections at both the inlet and the outlet of the fans, and that endless belts should be used where motors are not direct connected to fans. It was also suggested that in special cases it may be necessary to treat the fan room with acoustical material. The authors pointed out that even if all of these precautions are taken, considerable noise may be carried by the duct system from the fan room to the room served, or disagreeable noises may be developed in the duct system itself, particularly in systems using high air velocities. The tests reported in this paper show that these noises can be greatly reduced by lining the ducts with sound-absorbing material. As would be expected, the best results were obtained when the entire duct was lined.

In discussing this paper, W. H. Carrier stated that the designer and builder of equipment for modern ventilation must consider the problem as a whole, that is, he must consider all of the noise-making equipment—the fans, air washer, etc. Written discussions by Ernest Szekely and S. I. Rottmayer were read by Mr. Carrier. A. P. Kratz also read a written discussion, as did Mr. Ashley.

In his discussion, Mr. Szekely stated that he hoped the authors would continue their experiments to a final conclusion, and that they would determine the relationship that exists between pitch, amplitude and absorbing surface, somewhat along the lines Professor Sabin's experiments were carried out in connection with acoustical treatment of spaces. In Mr. Rottmayer's discussion, attention was called to the fact that sound-absorbing materials may be rated for absorption of sound of a certain pitch and several examples were given.

H. P. Reid inquired as to the results, should these investigations be made on a round duct instead of a rectangular or square duct. He asked if the diaphragm action of the duct wall would be thereby affected and also called attention to multi-duct systems where talking and other noises are transmitted to various parts of the building. The speaker inquired about different types of lubrication and of different types of bearings on the noise transmission through the system.

J. D. Edwards called attention to one factor which has not been given consideration, namely, the kind of metal used in construction, and related an incident with which he was familiar involving metal desks. It was found that desks made of one type metal were much noisier than desks made of another type. He attributed the difference in this case to the difference in the physical characteristics of the two metals.

E. B. Langenberg related some of his experiences in connection with residence work, and told how it was necessary in some cases to increase the duct sizes to take care of the necessary volume and to reduce the velocities. He also pointed out that they were able to reduce stratification to a great extent in this manner. He said that a great deal depends on the type of fan, and that frequently different types of fans are needed for different types of installations. He spoke about the necessity for smooth joints, and of smooth canvas connections. Duct supports, he revealed, are also of considerable importance and they must be so applied that noises will not be communicated to the floors above.

In closing the discussion, Professor Norris referred to remarks made by Professor Kratz, particularly with respect to increasing the size of the duct to get an increase in the area, and admitted that this was a good suggestion. Professor Norris drew attention to the fact that sound reduction depends on the hydraulic radius of the duct, and if a larger duct is used, proportionately longer lengths of acoustical lining must be used to get the same effect as with a shorter length. He stated that the reason why they used 32 holes per square inch, and a 1/16 in. hole, was that material of this type was available. The number of holes could be reduced in the experimental work to about one hole for every 1¼ sq. in. without getting into serious difficulties, Professor Norris revealed, but beyond a certain point they began to get reflection of the sound. It was pointed out by the speaker that as far as elbows are concerned there should be no more noise set up than in a similar length of straight duct, although in practice there usually is, and under the circumstances the best procedure is to place a certain amount of acoustical material immediately after the elbow on the discharge side to absorb that noise as quickly as it is formed.

The report of the Finance Committee was submitted by F. C. McIntosh, chairman, as follows:

Report of Finance Committee

The past year has not been a particularly prosperous one. More men than usual were obliged to cut down all possible expenses and the collection of dues was affected. Advertisers in THE GUIDE were inclined to reduce their advertising appropriations and the financial success of this, our other main source of revenue, was threatened.

However, the year turned out to be a profitable one for us. Due to the conscientious and effective work of Mr. Farrar, the

total membership was increased sufficiently to give a net gain of over $2,000 from initiation fees and dues. Our normal expenses for the year were held to about the same as for 1929, and other sources of income, such as sales of TRANSACTIONS, reprints and books, were increased enough to pay the expenses of moving to our new offices and of procuring the additional furniture and equipment needed.

In spite of increased resistance, Mr. Hutchinson was able, by great effort, to increase the income from advertisements in THE GUIDE by 12½ per cent and to increase the copy sales by 15 per cent. The cost of the promotion work was greater than estimated, but the extra cost was more than offset by the saving in production costs. Mr. Hutchinson deserves as much credit for reducing expenses as for increasing the revenue.

As a result of these conditions, our General Fund has been increased from $28,591.56 to $32,188.72 and THE GUIDE profit available for turning over to the Research Laboratory will be more than last year. The full report of our finances and operations was made by our certified public accountant, Frank Tusa.

The amendment to our Constitution fostered by Mr. Jones and adopted at Philadelphia a year ago requires that our funds be invested in securities listed as legal for investment of savings bank funds in the State of New York. Because of the general depression in the bond market and the fact that the higher yield bonds we have held are naturally more depressed than the low yield securities we must buy, it has been thought inadvisable to sacrifice principal by immediate reinvestments. However, as it has been possible to sell about 30 per cent of our securities at a slight profit, we have done so and invested the proceeds according to the amendment. This policy of the Council will probably be continued so as to make reinvestments at the most favorable times.

Respectfully submitted,
F. C. McIntosh, *Chairman,*
Thornton Lewis,
W. T. Jones.

The foregoing report was duly approved by vote.

Report of Certified Public Accountant

FRANK G. TUSA
Certified Public Accountant
Audits—Tax Service—Systems
Italian Savings Bank Building
New York

January 15, 1931.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS,
51 Madison Avenue,
New York City.

Gentlemen:—

Pursuant to your request I made an examination of the books of account and records of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS—NEW YORK CITY, for the year ending December 31, 1930, and submit herewith my report.

The work covered a verification of the Assets and Liabilities as of the date previously stated and a review of the operating accounts. For the past calendar year, the recorded cash receipts were traced into the depositories; the cancelled bank vouchers were compared with the cash disbursement records; and the membership dues were accounted for.

Submitted herewith is a Balance Sheet showing the financial condition of the Society on December 31, 1930, and your attention is directed to the following comments thereon:

CASH

Cash on deposit was verified by direct communication with the banks listed below and by reconcilement of the amounts reported to me with the balances shown by the books of the Society:

Banks	*Amounts*
Chase National Bank (Special) Treasurer	$2,283.21
Chase National Bank (Regular) Secretary	1,775.04
Bankers Trust Company (Special Interest)	1,425.25
Bank of America N. A.	113.70
Bank of United States	500.00
Federation Bank and Trust Company (Pass Book No. 28992)	2,628.55
	$8,725.75

The petty cash on hand was counted and found correct.

MARKETABLE SECURITIES

There is attached hereto a schedule of negotiable bonds which were verified by me either by direct communication with the Bankers Trust Company where same are deposited for safekeeping or by count of those on hand. No adjustment has been made of the $5,805.67 shrinkage in the market value of these securities, instead I have included them on the Balance Sheet at cost and indicated the market value of December 31, 1930 adjacent thereto.

ACCOUNTS RECEIVABLE

Unpaid membership dues were determined by trial balance of the individual ledger cards and comparison of same with the Dues Register. A summary of these as to years charged is shown below:

1930 Unpaid Dues	$9,889.24
1929 Unpaid Dues	3,382.65
1928 Unpaid Dues	560.00
Total	$13,831.89

My verification of the dues disclosed that during the year 1930 there had been prepaid to the Society dues amounting to $509.65. These I have shown on the attached Balance Sheet as deferred income.

Based upon previous experience it is estimated that only one-third of the current year's dues are realizable. Accordingly I have provided a Reserve for 1930 Dues Doubtful of Collection of $6,592.83. This is equivalent to two-thirds of the 1930 Unpaid Dues. After reviewing the 1928 and 1929 Dues it appears that very little will be realized from this source, therefore I have increased the reserve for prior years' dues doubtful of collection to $3,643.08.

A comparison of the membership in force as of the close of business, December 31, 1929 and 1930, respectively, follows:

Classification	*1930*	*1929*	*Increases*
Members	1,485	1,424	61
Associates	480	405	75
Juniors	246	156	90
Students	16	1	15
Honorary	2	2	0
	2,229	1,988	241

Trial Balances were also taken of Accounts Receivable resulting from Advertisements and sales of Guides, Codes, Books and Reprints. All available data examined and a discussion with the management relative to these accounts shows that the reserve of $1,000.00 provided on the books is sufficient to cover future contingencies.

INVENTORIES

There is scheduled below the inventory of Transactions taken on December 31, 1930:

Year	*Volume*	*Number*	*Price*	*Amount*
1923	29	142	$1.97½	$280.45
1924	30	280	1.38¼	387.11
1925	31	174	.96 1/6	167.34
1926	32	114	1.26 4/5	144.57
1927	33	163	1.32 1/5	316.45
1928	34	232	1.43	331.76
Total				$1,627.68

Transactions covering the year 1929, Volume 35, and the year 1930, Volume 36, were not published up to the close of the past year, therefore reserves of $3,000.00 each have been provided to cover the future cost of producing the aforementioned volumes.

All other Inventories were verified either by actual count or analysis of the records.

ACCOUNTS PAYABLE

A list was compiled of all invoices remaining unpaid on December 31, 1930 dating prior to January 1, 1931, for the purpose of determining all Accounts Payable and a liability therefore was set up in the sum of $15,169.77. This sum includes charges from Horn-Shafer Company of $13,270.00 for costs covering the printing of The Guide and Year Book.

DUE RESEARCH LABORATORIES

Of the dues charged to Seniors and Associates, 40 per cent has been reserved for the Research Laboratory in accordance with Section 5, Article 3 of the By-Laws. The sum payable to the Research Laboratory as and when the Dues Receivable will have been realized in cash is $16,788.10.

ACCRUED ACCOUNTS

A Bonus of $7,809.57 to the staff of the Society has been included as a liability on the subjoined Balance Sheet. The computation of this Bonus has been made in accordance with a resolution adopted by your council at a meeting held on June 24, 1930.

GENERAL FUND

An Analysis of the General Fund of the Society showing the changes made therein during the year under audit follows:

GENERAL FUND DECEMBER 31, 1929—PER FORMER REPORT		$28,591.56
ADDITIONS		
Profit from Society Activities for the Calendar Year 1930 from Society Statement of Income and Expenses	$3,538.94	
Add: Amount assumed by Society for F. Paul Anderson Medal Award included as an expense in the Statement previously mentioned	500.00	
	$40,038.94	
Profit from Guide for the Calendar Year 1930 from Guide Statement of Income and Expenses	9,784.65	
Adjustment of items covering Council and Special Meetings expenses assumed by Society in 1929 which are chargeable to Research	311.38	$14,134.97
		$42,726.53
DEDUCTIONS		
Additional amount set aside for Endowment Fund to bring said fund to the Cost Value of $20,000.00 par value of Bonds voted by Council at a meeting held on June 24, 1930	9,337.81	
Increase in Reserve for Prior Years' Dues Doubtful of Collection	1,200.00	$10,537.81
GENERAL FUND DECEMBER 31, 1930 PER BALANCE SHEET		$32,188.72

Respectfully submitted,

FRANK G. TUSA,
Certified Public Accountant.

BALANCE SHEET

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
DECEMBER 31, 1930.

ASSETS

SOCIETY				
CASH				
On Deposit		$ 8,725.75		
On Hand		100.00	$ 8,825.75	
INVESTMENTS (AT COST)				
Securities (Market Value $12,760.00)		12,919.49		
ADD: Accrued Interest		152.92	13,072.41	
ACCOUNTS RECEIVABLE				
Membership Dues	$13,831.89			
LESS: Reserve for Doubtful	10,235.91	3,595.98		
Advertisements	43,582.68			
Guides	1,284.25			
Codes	108.55			
Books and Reprints	102.71			
	45,078.19			
LESS: Reserve for Doubtful	1,000.00	44,078.19	47,674.17	
INVENTORIES				
Transactions 1923-1928		1,627.68		
Transactions 1929 in Process		513.46		
Transactions 1930 in Process		50.86		
Emblems		86.35		
Postage—General		277.40	2,555.75	
PERMANENT				
Library		300.00		
Furniture and Fixtures	7,451.39			
LESS: Reserve for Depreciation	3,985.68	3,465.71	3,765.71	$75,893.79
SPECIFIC FUNDS				
ENDOWMENT FUND				
Securities at Cost (Market Value $14,350.00)		19,753.68		
ADD: Accrued Interest		250.83	20,004.51	
F. PAUL ANDERSON AWARD FUND				
Cash on Deposit			1,023.43	
RESEARCH LABORATORIES FUND				
Cash on Deposit—Research	5,365.60			
Cash on Deposit—Research Endowment Fund	610.04			
Cash on Hand for Deposit	21.00	5,996.64		
Securities at Cost (Market Value $3,015.00)	3,007.50			
ADD: Accrued Interest	45.00	3,052.50	9,049.14	30,077.08
				$105,970.87

LIABILITIES AND CAPITAL

SOCIETY			
ACCOUNTS PAYABLE		$15,169.77	
DUE RESEARCH LABORATORIES			
Dues	$13,191.08		
Interest from Endowment Funds	1,025.00	14,216.08	
ACCRUED ACCOUNTS			
Bonus to Staff		7,809.57	
RESERVE FOR TRANSACTIONS			
1929	3,000.00		
1930	3,000.00	6,000.00	
DEFERRED INCOME			
Prepaid Dues		509.65	
TOTAL LIABILITIES		43,705.07	
GENERAL FUND			
Society		32,188.72	$75,893.79
SPECIFIC FUNDS			
Endowment		20,004.51	
F. Paul Anderson Award		1,023.43	
Research Laboratories	8,439.10		
Research Endowment Fund	610.04	9,049.14	30,077.08
			$105,970.87

Note "A": The General Fund of the Society is subject to future adjustment pending action to be taken by council on the assignment of the Guide Profit for the Calendar Year 1930.

Note "B": This Balance Sheet is subject to the comments contained in the letter attached to and forming a part of this report.

The paper, Air Conditioning as Applied to Furniture, Fixtures and Other Interior Woodwork, by D. R. Brewster, was presented by title in the author's absence. (The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, January 1931, p. 65).

J. D. Edwards presented a very interesting discussion of this paper and among other things, stated that the use of moisture-proofing coatings is only a partial solution of the problem and that this partial solution will not relieve the heating and ventilating engineer from doing his part. He contended that only by the active co-operation between the heating and ventilating engineer and the manufacturers of wood products can the best results be obtained.

W. L. Fleisher presented his paper on Air Conditioning in the Bakery, and gave a summary of the subject matter involved. The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, February 1931, p. 158.)

R. P. Bolton complimented the author on this paper, and presented a very interesting general discussion. In further explanation of the paper, it was stated by Mr. Fleisher that the bakery was simply taken as an example of a complex subject which, due to the amount of chemical study that had been made, was susceptible of analysis. In order to clarify the matter, he stated that the subtitle of his article should have been, "The Change in Moisture Content of Most Colloidal Materials or Conglomerates Is Due to a Change in the Iso-electric State of the Material Through a Differential in Electrical Potential between the Material and the Potential of the Surrounding Atmosphere." It was emphasized that the particular activity of the product for its best condition is a function of the *pH* concentration and that there is a particular *pH* concentration of the surrounding atmosphere which lends itself best to the maintenance of that particular condition in the material. A change in an electrical condition, Mr. Fleisher pointed out, can only be brought about by superimposing an electrical force and consequently any changes that do take place must necessarily be basically electrical. The author stated that in the realm of comfort the electrical equilibrium of our bodies, superficially and internally, can only be changed by an electrical impulse contacting with them, and the ionization of the air, translating heat factors to electrical factors or ionized factors, are the basic energies which check or change our metabolism to create comfort or discomfort. Just as flour, gluten, yeast and doughs can be analyzed, and as equations between their electrical forces and the surrounding electrical forces would give the best results, so this same method can be applied to many other products such as paper, ceramics, tobacco, and finally, the most important of all, human beings. Mr. Fleisher emphasized that it is the function of the mathematician and the physicist to establish this mathematical balance.

Air Conditioning for Railway Cars, by A. H. Candee, was the next paper on the program, and was presented by the author. (The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, December 1930, p. 1037.) After Mr. Candee's presentation of this paper in abstract, Mr. Ragsdale informed the audience that the Santa Fé Railroad was using the same system for heating in the winter as for cooling in the summer. He also revealed that the M. K. & T. Railroad contemplates adopting the same principle.

W. H. Carrier corrected the author on certain statements that had been made, as Mr. Carrier designed the first car described in the paper. He emphasized particularly that in developing this installation it was found that the theoretical calculations could not be applied in car design, and that a considerable amount of experimental work was necessary to obtain satisfactory results. Mr. Carrier expressed his appreciation to the author for the paper. In closing the discussion, Mr. Candee alluded to the power requirements of the installation.

The report of the Committee on Oil-Burning Devices was presented by R. V. Frost, in the absence of L. E. Seeley, Chairman. The report consisted of the presentation of the proposed code for Testing Steam Heating Boilers Burning Oil Fuel, copies of which had previously been sent to members of the Society. (The revised edition of this code will appear in an early issue of the Journal Section.)

The Technical Advisory Committee on Oil Burning Devices, which prepared this proposed code, consisted of L. E. Seeley, *Chairman*, H. F. Tapp, P. E. Fansler, H. R. Linn, J. H. McIlvaine, R. V. Frost and F. C. Houghten. The major divisions of the code consist of Definitions, Set-up of Oil Burner and Boiler to be Tested, Instruments and Measuring Apparatus, Fuel Sampling, Duration of Tests, Starting and Stopping Continuous Tests, Starting and Stopping of Intermittent Tests, Method of Conducting Test and Performance Charts.

R. F. Connell made inquiry about several recommendations in the code and offered a number of suggestions and additions based on his experience in boiler testing and research.

Written comments on the proposed code prepared by C. H. Flink, New York, were read by H. R. Linn. Mr. Flink suggested that the short test form be eliminated, and that the standard form be used for both standard and short tests. He suggested changes in paragraphs 17, 19, 22, 27 and 35.

C. E. Bronson suggested that the test be not less than of four hours' duration rather than two hours as specified in paragraph 45. He also offered his ideas on placement of apparatus to insure accuracy in testing.

In a written discussion, H. M. Hart offered several constructive suggestions. He thought the conditions required in the test should be as near the operating conditions as was practical. He was also of the opinion that a longer period for heating up should be allowed when using oil burners, for the reason that the average oil burner always operates at maximum rate. He suggested that five tests be run similar to those required for solid fuel firing by varying the load on the boiler, the minimum load being about 25 per cent of the design load. Mr. Hart thought it advisable to limit the maximum output of oil burners to some definite rate per cubic foot of combustion space.

J. F. McIntire expressed the opinion that too much emphasis had been placed on the use of the combustion

space as a measure for the duration of test. He thought that paragraph 45 should specify the limit of the total quantity of oil burned to develop the desired output of the boiler, and should not limit it to a certain number of pounds of oil per cubic foot of combustion space. He suggested that the intermittent test be specified as a certain percentage of the amount of oil that would be burned by the burner, if it were operated continuously.

F. C. Hvoslef brought up the question as to the kind or type of burners to be used, inasmuch as the code is for testing boilers and not burners. He stated that the manufacturer will select the best burner he can find, and the owner may buy the cheapest burner he can select, with the result that it would not heat the house properly. This speaker stated that he was very much in accord with almost all of the criticisms submitted.

Mr. Frost stated that the criticisms would be passed on to the committee, and he moved that the report of the committee be accepted, and referred to a continuing committee with instructions that the criticisms submitted at the meeting be considered and embodied in the final draft of the code. The motion was carried.

Vice-President Carrier presiding, asked if any one desired to contribute any further discussion on Mr. Frost's paper presented at the first session. R. A. Miller responded and stated that mention had been made of the radiation through glass surfaces, and called attention to a statement that had been made to the effect that since rooms are built with a considerable amount of glass surface, and as the ratio of glass to exposed wall surface is on the increase, an increasing radiation loss from this source is probable. He pointed out that the loss of heat by radiation through glass is quite important. Mr. Miller stated that his organization contemplated some thorough investigations on heat transfer and heat losses through various glass panels, for the purpose of determining the value of the air spaces between two glass plates.

Mr. Carrier asked Mr. Miller if he could give any figures on the amount of heat reflected by glass, to which Mr. Miller replied that he was unable to give any definite figures at the present time. He stated that plate glass reflects about 4 per cent of the light coming to it, whether the light comes from an angle or not, but was unable to state what the reflection of other radiating energy would be. Messrs. Carrier and Miller discussed reflection, absorption and conductance of heat through glass. Mr. Miller stated that the conductance of the glass is apparently the prime factor rather than the transmission of radiant energy directly. Direct radiation, he stated, goes through the glass in apparently imperceptible quantities.

Mr. Frost said that the point he endeavored to bring out in the paper was that the radiant energy from the warm surface of the radiator is dissipated through the glass much more rapidly than would be the heat transmitted by the air to the glass surface.

Mr. Carrier said that until two years ago he thought it possible to radiate heat directly through glass, but found that so far as the long wave lengths were concerned, he had been in error. He explained that one can look through glass and that naturally one would think that heat can be radiated through it also, but that the heat is merely radiated to the cold glass surface, and in turn radiated from the outside glass surface. Convection, he stated, also takes place on both surfaces. Mr. Carrier expressed the hope that Mr. Miller would present a paper before the Society on this subject, at an early date.

Fourth Session—Wednesday, January 28—9:30 A. M.

The Wednesday morning session was held at the U. S. Bureau of Mines Building, in which the A. S. H. V. E. Research Laboratory is located, and the opening address was given by O. P. Hood, Chief of the Technological Bureau of the Bureau of Mines, and Acting Director. Mr. Hood gave a brief description of the Bureau of Mines Research Laboratory, including its functions and other statements of interest in connection with it. He also told briefly of the formation of the Research Bureau of the Society.

President Harding expressed his appreciation for Mr. Hood's remarks, and then called on F. B. Rowley who, as Chairman of the Research Committee, submitted the report of that committee. Professor Rowley stated that it was particularly fortunate and appropriate to have the meeting at the Bureau of Mines, and thanked the Bureau for the assistance it had given the Society to help it get started. He stated that we should be greatly indebted to the Bureau of Mines for all they have done for us.

In continuing on the report for the year 1930, Professor Rowley stated that in addition to the research work which had been carried on at the Bureau of Mines, research had been conducted at a number of institutions and that at present there are eight universities and other agencies co-operating with the Society. He also pointed out that the extent of the research work of the Society is much greater from a financial point of view than the statement would indicate. He then dwelled somewhat on the question of commercial research or commercial testing, and said that only one request of importance for this work had been received. He pointed out that the main obstacles in the way of commercial test work are the facilities and the location for doing it. High-class institutions, he stated, are not usually willing to undertake commercial testing.

Professor Rowley referred briefly to the financial condition of the laboratory. He said that while our funds this year show a considerable increase over last year, the increase was not due entirely to this year's work due to incompleted projects being carried over, and other reasons. Referring to the Report of the Committee on Research, submitted herewith, Professor Rowley stated that the real financial standing of the laboratory, so far as cash is concerned, was $25,000.00. Attention was called to the fact that there is an increase in the contributions coming from associations interested in research. After the Report of the Chairman of the Research Committee was submitted by Professor Rowley, the Report of the Director was submitted by F. C. Houghten.

PITTSBURGH EXPERIMENT STATION OF THE U. S. BUREAU OF MINES WHERE THE RESEARCH LABORATORY OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS IS LOCATED

Report of the Committee on Research for 1930

(January 15, 1931)

Part I

REPORT OF THE CHAIRMAN

By F. B. Rowley

THE work of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS' Research Laboratory covers a wide range of interests, and one of the difficulties is to present in a condensed report the results of these activities so that the members of the Society who are of necessity more or less disconnected with them throughout the year may become reasonably familiar with the work.

The work of the Laboratory is under the supervision of a committee of fifteen members and a director. The general committee has held three meetings during the year. However, due to the difficulty of calling a large committee together, the greater part of the work has been handled through the Executive Committee, the Director, and the Technical Advisory Committees for the various projects. As in the past, the policy has been to conduct as much of the work as possible at the Pittsburgh Laboratory and to maintain co-operative projects with universities and other institutions where the proper facilities and interests are available.

While the rules and regulations governing the Laboratory's activities passed at the 1930 annual meeting anticipated that the Laboratory might conduct commercial tests, only one request has been received for this type of work during the past year. This was a request from the *Heating and Piping Contractors' National Association* for the rating of radiators. Plans for procedure were prepared by the Technical Advisory Committee on Radiation, and the Association was advised of the conditions under which the Laboratory proposed to make the tests. Due to the adverse financial conditions for the year, however, the Association decided not to go ahead with the work. Due to the difficulty of finding a proper place for conducting various commercial tests under the existing arrangements for the Laboratory, it seems doubtful whether commercial testing is advisable until such time as specific arrangements can be made for laboratory facilities to take care of it.

After working for a year under the new Laboratory regulations, there are certain minor changes which it appears advisable to make, some of them to make the regulations conform with the Constitution of the Society, and others to simplify the operation of the Committee. D. S. Boyden has been appointed as a committee of one to go over the regulations and recommend the necessary changes to the Society for adoption.

Technical Advisory Committees

The various projects for the year have been under the direction of eleven Technical Advisory Committees. The work of these various committees is covered in Part II in the report of F. C. Houghten, Director.

Co-operative Research

The institutions at which co-operative research programs are carried on and the subjects under investigation at these institutions are as follows:

Armour Institute: Measurement of Air Flow Through Registers and Grilles.

Harvard School of Public Health: The Ionization of Air and Its Relation to Health.

Washington University: Atmospheric Dust and Smoke.

University of Wisconsin: Infiltration of Air and the Drift of Air Through Buildings.

University of Minnesota: Transmission of Heat Through Building Materials, a study of Air Cleaning Devices, and The Thermal Properties of the Different Species of Wood, in co-operation with the *National Lumber Manufacturers' Association.*

Texas Agricultural and Mechanical College: Pipe Sizes for Steam and Hot Water Heating.

Carnegie Institute of Technology: Capacity of Pipes for Various Parts of a Steam Heating System.

Yale University: Study of Oil Heating Devices.

Co-operative research projects are under consideration by other institutions, as, the University of Illinois, Purdue University, and the Massachusetts Institute of Technology.

The general plan of the co-operative projects is that the finances are furnished equally by the Research Laboratory and the co-operating institution, with space, equipment, and supervision furnished by the institution. By this arrangement, the Laboratory is able to accomplish very much greater results with a small amount of money than would otherwise be possible.

Financial Report of Research Laboratory

COMMITTEE ON RESEARCH
AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
TOTAL INCOME AND EXPENSES
1923 TO 1930

INCOME

YRS.	DUES (40%)	GUIDE PROFITS	CONTRIBUTIONS	INTEREST	TOTAL RECEIPTS	EXPENDITURES
1923	.....	.....	.....	.....	$28,903.98	$33,235.43
1924	.....	.....	.....	.....	16,920.29	21,519.91
1925	$13,604.88	.....	$13,512.57	.....	27,117.45	17,623.82
1926	22,597.53	$ 6,994.24	5,805.00	$322.05	35,718.82	26,607.49
1927	13,513.54	4,401.60	14,209.04	289.84	32,414.02	35,324.83
1928	12,722.96	4,022.55	12,690.32	144.38	29,580.21	32,017.90
1929	16,941.47	6,227.20	10,257.87	110.05	33,536.59	33,683.15
1930	14,104.75	4,973.50	26,720.28	340.40	46,138.93	40,486.26

FINANCIAL STATEMENT
A. S. H. V. E. LABORATORY
JANUARY 1, 1931

Research Fund (Dec. 31, 1930)		
N. Y. Bank	$ 5,386.60	
Pittsburgh Bank	1,695.38	
Petty Cash	46.66	
Other funds 1. Research Endowment	610.04	
2. Securities and Interest	3,052.50	
3. Due Research from A. S. H. V. E. Dues	13,191.08	
4. Due Research from A.S.H.V.E. Endowment Fund	1,025.00	
		$25,007.26

STATEMENT 1930 OPERATIONS

INCOME		
Balance (Dec. 31, 1929)	4,763.47	
Receipts from A.S.H.V.E. Dues and Guide	19,078.25	
Receipts from Contributions and Contracts	26,720.28	
Interest from Bank acct. 176.01		
Securities 164.39	340.40	
		50,902.40
EXPENSES		
Salaries (Director and staff)	23,310.50	
Travels (Director and staff)	1,791.01	
Travels (Committee Members)	761.32	
Lab. Equipment and Supplies	1,697.45	
Office Expense	848.28	
Meetings	103.45	
Executive Secretary	2,041.75	
University Cooperation	9,932.50	
		40.486.26

COOPERATIVE AGREEMENTS

	BUDGET	PAID 1930
Armour Institute of Technology	$800.00	$700.00
Harvard University	500.00	500.00
Texas A. and M. College	250.00	250.00
Texas Engineering Experiment Sta	650.00	400.00
University of Minnesota	1,750.00	1,750.00
University of Minnesota (Special)	2,500.00	2,500.00
Washington University	70.00	70.00
Yale University	1,812.50	1,762.50
University of Wisconsin	1,500.00	1,500.00
Assn. for Cor. Ther. Res	500.00	500.00
	$10,332.50	$9,932.50

CONTRIBUTIONS OF MANUFACTURERS
(PAID IN 1930)

Aerofin Corp	$ 100.00
American Blower Corp	1,000.00
American District Steam Co	100.00
Armstrong Cork & Insulation Co	150.00
Babcock & Wilcox Co	100.00
Barnes and Jones ($200.00 due—Nov.)	200.00
Bradley Heating Co	25.00
Buffalo Forge Co	1,750.00
Carrier Engineering Corp	300.00
Celotex Co	100.00
Crane Co	100.00
Engineering Publications, Inc	100.00
Hoffman Specialty Co	750.00
Ilg Electric Ventilating Co	200.00
Jaros and Baum	10.00
Johnson Service Co	500.00
Kewanee Boiler Co	1,000.00
Masonite Corp	200.00
May Oil Burner Corp	50.00
Nash Engineering Co	335.00
National Regulator Co	250.00
Herman Nelson Corp	1,000.00
J. J. Nesbitt, Inc	100.00
Peerless Unit Ventilation Co., Inc	200.00
Powers Regulator Co	200.00
Sheldon's, Ltd	50.00
B. F. Sturtevant Co	250.00
Trane Co	200.00
United Engineers and Constructors, Inc	100.00
U. S. Gypsum Co	50.00
Walworth Co	100.00
Warren Webster and Co	500.00
L. J. Wing Mfg. Co	100.00
Wolverine Tube Co ($25.00 due—Oct.)	50.00
York Heating and Ventilating Corp	400.00
	$10,270.00

FUNDS PAID BY ASSOCIATIONS

Air Filter Association	$ 600.00
American Oil Burner Association	1,500.00
Associated Copper Tubing Manufacturers	500.00
Chicago Master Steam Fitters Association	1,000.00
Common Brick Manufacturers Association	375.00
National Lumber Manufacturers Association	6,085.97
Ontario Chapter, A. S. H. V. E	132.00
Ventilating Contractors Employers Association, Chicago	300.00
International Exposition Co	5,477.31
	$15,970.28

MISCELLANEOUS PAYMENTS

Balance Forward	$26,240.28
University of Toronto, (One Nicholls Heat Meter)	150.00
University of Illinois, (Two Nicholls Heat Meters)	300.00
F. C. Houghten	30.00
	$26,720.28

One of the outstanding features of the work for the year is that, in spite of the difficult financial times, the Laboratory budget has continued to grow, which proves the interest of the members, the industry, and various associations in the work of the Society and the Laboratory. It is significant that the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS is the only national society which maintains such a laboratory, and the evident interest in the work indicates that the Research Laboratory has a very bright future.

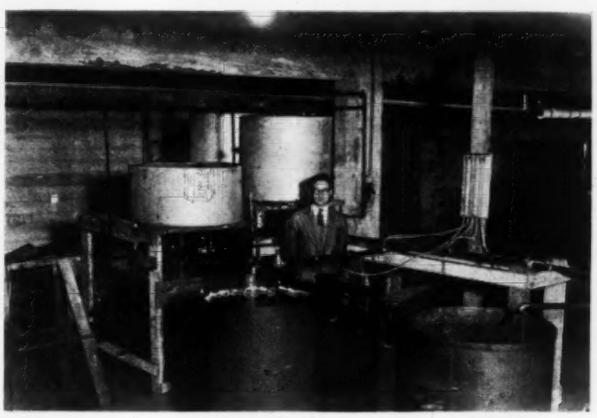


FIG. 1—SET-UP OF APPARATUS AT AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS FOR DETERMINING THE FRICTION OF WATER IN TEES WHEN THE WATER FLOWS THROUGH THE TEE IN THE SEVERAL POSSIBLE DIRECTIONS

Part II

REPORT OF THE DIRECTOR

By F. C. Houghten

THE year 1930 has witnessed marked progress in the various activities of the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS. The work of the Laboratory is divided into eleven phases covering separate branches of our engineering knowledge; each phase of the work is carried on either in the Laboratory at Pittsburgh or in one or more of the eight co-operating institutions under the guidance of one of the technical advisory committees referred to in this report.

Marked progress was made on all the eleven research investigations. The work on some of these activities was brought to a sufficient stage of completion to result in conclusive and acceptable data of such a nature as to be usable in THE GUIDE.

The following nine technical papers for presentation at the 1930 Semi-Annual and the 1931 Annual Meetings of the Society were completed during the year:

1. Surface Conductances as Affected by Air Velocity, Temperature, and Character of the Surface, by F. B. Rowley, A. B. Algren, and J. L. Blackshaw; JOURNAL of the Society (Heating, Piping and Air Conditioning), June, 1930.
2. Air Infiltration Through Various Types of Wood Frame Construction, by G. L. Larson, D. W. Nelson, and C. Braatz; JOURNAL of the Society, June, 1930.
3. Capacity of Dry Return Mains for Steam and Vapor Heating Systems, by F. C. Houghten and Carl Gutberlet; JOURNAL of the Society, August, 1930.
4. Capacity of Return Risers for Steam and Vapor Heating Systems, by F. C. Houghten and Carl Gutberlet; JOURNAL of the Society, October, 1930.
5. Loss of Head in Submerged Orifices, by F. E. Giesecke; JOURNAL of the Society, July, 1930.
6. Carbon Monoxide Concentration in Garages, by A. S. Langsdorf and R. R. Tucker; JOURNAL of the Society, August, 1930.
7. Air Leakage Through Various Types of Building Construction, by F. C. Houghten, Carl Gutberlet, and C. A. Herbert; JOURNAL of the Society, December, 1930.
8. Wind Velocity Gradients Near a Surface and Their Effect on Film Conductance, by F. C. Houghten and Paul McDermott; JOURNAL of the Society, March, 1931.
9. Code for Testing Steam Heating Boilers Burning Oil Fuel, by Technical Advisory Committee on Oil Burning Devices, L. E. Seeley, *Chairman;* H. F. Tapp, P. E. Fansler, H. R. Linn, John H. McIlvaine, R. V. Frost and F. C. Houghten.

1. Pipe Sizes for Steam and Hot Water Heating Systems

Technical Advisory Committee
H. M. Hart, *Chairman*
F. E. Giesecke
R. C. Morgan
C. V. Haynes
S. E. Dibble.

a. Capacity of Pipe for Various Parts of a Hot Water Heating System.

The study of pipe sizes for hot water heating systems is carried on by Professor Giesecke and his associates at the Agricultural and Mechanical College of Texas through a co-operative agreement with the Laboratory. This work has for its primary object the development of pipe size tables for laying out hot water heating systems which may be incorporated in THE GUIDE.

Professor Giesecke has had this work under way for several years and at the 1930 Annual Meeting, Prof. E. G. Smith of the A. & M. College of Texas, presented a very comprehensive paper, which included a method for laying out the various parts of a hot water heating system. The values are being rechecked before this report is accepted as final. Additional information on the subject in the nature of a technical paper is promised for the near future.

In addition to the work on actual hot water heating systems, Professor Giesecke is also making a study of the loss in head due to the flow of water through various fittings, including ells and tees. The work particularly includes a study of the loss in head for water flowing through two branches of a tee, a subject on which little or no data are available at present.

Fig. 1 shows the set up of apparatus at the Agricultural and Mechanical College of Texas for this study. Prof. W. H. Badgett, who is making the tests, is shown in the picture. The manometer tube, consisting of five vertical branches, is connected in such a way that it indicates directly the friction head through the tee in two directions and the quantity of water flowing in the three directions, the latter being measured by means of the loss of head through calibrated orifices. This installation is a modification of the installation used to determine the losses of head through orifices and has been improved by the addition of a tank by means of which the temperature of the water is regulated within one or two degrees of that desired.

b. The Capacity of Pipe for Various Parts of a Steam Heating System.

The study of pipe sizes for steam heating systems began in 1922 and has continued to date. This work is carried on by the Research Laboratory at the Carnegie Institute of Technology, Pittsburgh. During the past two years the work has been directed toward the determination of pipe sizes for the return side of the system. In this connection, a report was presented at the

1930 Summer Meeting of the Society, and published in the August, 1930, JOURNAL. The report gave the relation between pressure drop and the flow of water and air in horizontal pipe. A paper entitled Capacity of Return Risers for Steam and Vapor Heating Systems was published in the October JOURNAL of the Society for presentation at the 1931 annual meeting. These two papers form the basis for a complete revision of the return sizes for steam and vapor heating systems as contained in THE GUIDE. The revision of the practical tables for use in THE GUIDE will be made through co-operation between the Laboratory and the Technical Advisory Committee and others interested in the practical application of the results. This is desirable since the development of such tables involves the question of allowing a suitable factor of safety over the capacities actually found in the Laboratory as well as such questions as the most desirable heating-up period.

The return pipe sizes in THE GUIDE tables will require a complete revision of these values based upon the Laboratory's findings since the work was undertaken in 1922. Additional work on pipe sizes which the Laboratory has under consideration includes a check of the application of the Babcock formula to the flow of steam in modern pipe. In recent years the art of making pipe has improved with the result that pipe now on the market has a smoother internal surface and contains fewer constrictions. This development has apparently resulted in a change in the flow pressure-drop relationships for the flow of steam.

2. Study of the Application of Copper Tubing to Steam and Hot Water Heating Systems

Technical Advisory Committee

S. R. Lewis, *Chairman*
W. M. Robinson
J. F. McIntire
A. P. Kratz
H. M. Hart
F. E. Giesecke

This is a new study recently inaugurated by the Laboratory in co-operation with the *Associated Copper Tubing Manufacturers,* whereby this Association is financing the entire study. The work includes a determination of the capacity of copper tubing for carrying steam in various parts of steam and hot water heating systems and also the heat emission from such tubing when bare, and when insulated with pipe covering. The study of the capacity of this tubing for steam heating systems is being made at the Laboratory in Pittsburgh. The work on the use of such tubing in hot water heating systems will be carried on by Professor Giesecke at the A. & M. College of Texas.

3. Garage Ventilation

Technical Advisory Committee

E. K. Campbell, *Chairman*
E. B. Langenberg
W. C. Randall
A. C. Davis
A. R. Acheson

The study of garage ventilation was undertaken by the Laboratory about a year ago and had as its object a study of the relation of the quantity of air handled, its temperature, velocity, and location of supply and exhaust and its quantity of the outside air added, to the concentration and distribution of carbon monoxide, gasoline vapors, and other obnoxious fumes in the garage. A few tests were made early in the year by Dean Langsdorf of Washington University in co-operation with the Laboratory in which the condition of the atmosphere in a certain garage in St. Louis was studied. The mild climate prevailing in St. Louis in the winter and the infrequency with which the windows and doors of the garage were closed, placed the investigators at a disadvantage and it was decided to remove the investigation to a colder climate. The Laboratory is now negotiating with Massachusetts Institute of Technology for a co-operative study of this subject. A committee of the Boston Chapter is co-operating with the Laboratory in this connection.

4. Transmission of Heat Through Building Construction and Building Materials

Technical Advisory Committee

A. E. Stacey, *Chairman*
P. D. Close
A. B. Algren
H. J. Schweim
A. P. Kratz

a. Determination of Heat Transfer Through Built Up Wall Sections by the Guarded Hot Box.

Professor Rowley at the University of Minnesota, in co-operation with the Research Laboratory, has been continuing this study throughout the year. Many standard walls containing various combinations of the more common building materials have been checked in the guarded hot box, resulting in more acceptable coefficients for these types of construction. This study has also served to verify the application of the accepted formula to the

FIG. 2—THREE ROOF SLABS OF THE SAME CONDUCTANCE BUT OF DIFFERENT HEAT CAPACITIES ON WHICH STUDY IS BEING MADE AT THE LABORATORY IN PITTSBURGH OF THE EFFECT OF HEAT CAPACITY ON HEAT TRANSMISSION UNDER SUMMER CONDITIONS. THE TEMPERATURE OF THE AIR IN THE SPACE BELOW THESE THREE ROOF SPECIMENS CAN BE CONTROLLED

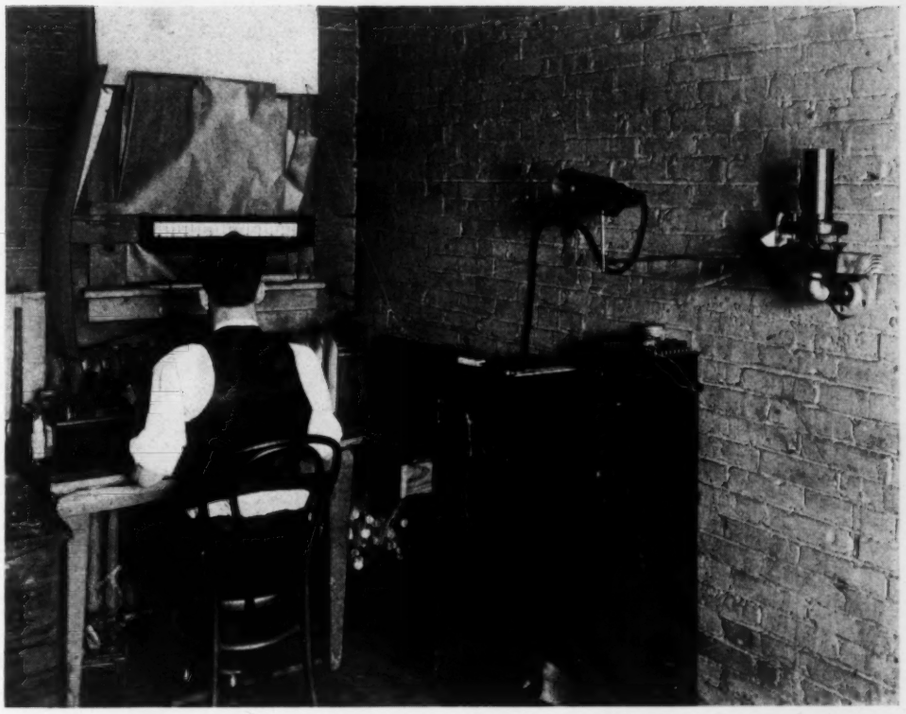


FIG. 3 — INSTRUMENT SET-UP FOR MEASURING HEAT TRANSMISSION THROUGH ROOF SLABS OF THE SAME CONDUCTANCE BUT DIFFERENT HEAT CAPACITIES. THE ROOF SLABS BEING TESTED ARE ON THE ROOF.

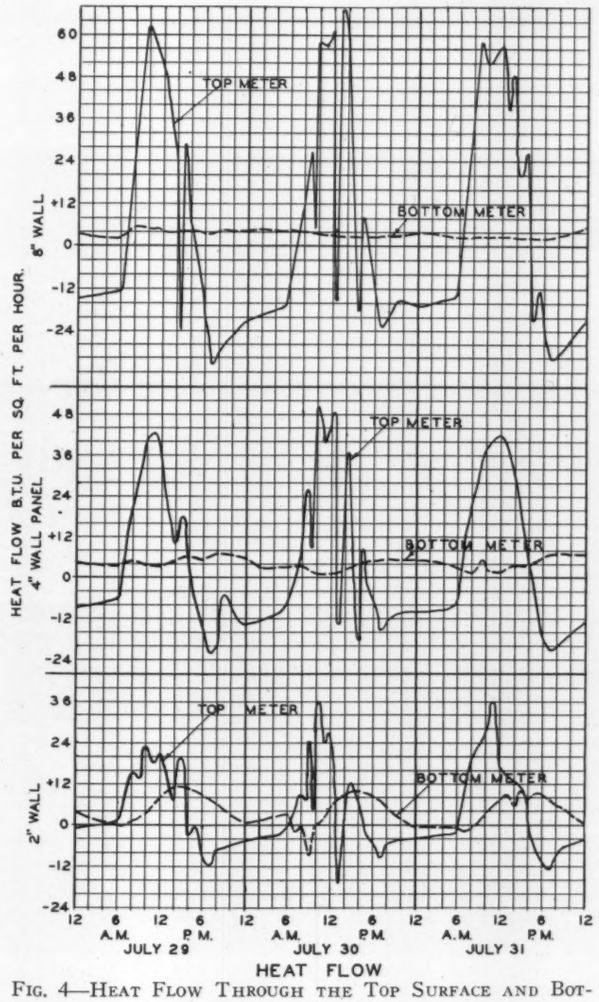


FIG. 4—HEAT FLOW THROUGH THE TOP SURFACE AND BOTTOM SURFACE OF ROOF PANELS 2, 4 AND 8 IN. THICK HAVING THE SAME CONDUCTANCE BUT DIFFERENT HEAT CAPACITIES

calculation of overall transfer co-efficients from the conductivity, air space, and film conductance co-efficients of the component parts of a wall.

b. Determination of Conductivity of Homogeneous Building and Insulating Materials.

This work is carried on at the University of Minnesota in co-operation with the Research Laboratory. In order to replace the many and varied co-efficients of conductivity for various simple building materials contained in THE GUIDE, with a consistent set of values obtained from materials now on the market and in common use, a study has been made of the conductivity of such materials as purchased on the open market. These tests are made in the guarded hot plate in accordance with the tentative code of the *National Research Council.* Conductivities have already been determined for a large number of materials purchased on the open market. In each case, three separate tests are made on samples obtained in different localities of the country. It is hoped that a technical paper, presenting the results of this study, will be available for publication in the spring and that the tabulated results may find their way into THE GUIDE in 1932.

c. Film Conductance Coefficient for Various Types of Surfaces for Still and Moving Air

Professor Rowley at the University of Minnesota, in co-operation with the Laboratory, has made a determination of film conductance coefficients for a number of surfaces for still and moving air for a condition where the direction of the wind is parallel to the surface and measured in the center of a 6-in. duct. A paper entitled Surface Conductances as Affected by Air Velocity, Temperature, and Character of Surface was published in the June 1930 JOURNAL, and presented to the Society at the 1930 summer meeting.

An allied study of another phase of the same study was made at the Laboratory in Pittsburgh. The object of this study was to establish information concerning the relation between wind velocity in free space and the existing velocities near a building wall, and also the effect of velocities as measured at various distances away from a wall on the resulting film conductance co-efficient.

In this connection, the Laboratory made a study of wind velocity gradients near a wall surface. This study has so far been limited to a study of such gradients when the wind direction was parallel to the wall surface. The most of the data

collected were for a wall attached to the side of a truck and moved forward through the air so as to produce the equivalent of a wind velocity, while the velocity and static pressures near the wall surface were surveyed with Pitot tubes. Similar velocity gradients were analyzed for a 6-in. and a 12-in. duct with wind blown through the duct.

Paralleling the study of wind velocity gradients, the Laboratory made a study of film conductance coefficients for a rough sanded surface and a smooth pine surface in a 12-in. and in a 6-in. duct. In these studies the object was not so much to determine usable coefficients for these conditions as it was to study the effect of the character of the wind velocity and position of its measurement on the coefficient which might be obtained. As a result of these studies a paper entitled Wind Velocity Gradients Near a Surface and Their Effect on Film Conductance is scheduled for presentation at the 1931 annual meeting.

d. Effect of Aging on the Conductivity of Concrete

This study has been under way at the Laboratory for the past three years during which time occasional tests have been made of the conductivities of two slabs of concrete of different mixes. These studies have shown a very high conductivity for concrete which is in keeping with a number of observations made in recent years both at the Laboratory and elsewhere. The study is further demonstrating the fact that the conductivity of concrete decreases with aging.

e. Absorption of Solar Radiation by a Roof or Wall Surface and the Effect of Heat Capacity of the Structure on Heat Penetration

For the past several years the Laboratory has been accumulating data on the effect of solar radiation on heat penetration into a building during the summer. This information is of vital importance to the air conditioning engineer. The early work on this subject gave information on the heat penetration through the lower surface of a roof or inner surface of a wall during warm summer days, and the variation in this rate of penetration throughout the 24-hour cycle. Early in 1930, the Laboratory presented data on the rate of heat absorption by the outside surface of a roof or wall depending upon the temperature and character of the surface, its angle, with the direction of the sun's rays and other factors including data on the absorption of heat from solar rays by a plate of glass through which the sun shines.

More recently the Laboratory undertook a study of both the absorption of heat at the outside surface and its penetration through three roof panels for certain hot, sunny days in July, August, and September. See Figs. 2, 3 and 4. This information is not yet sufficiently complete to warrant a conclusive technical paper on the subject. However, it is of interest to note the following facts demonstrated by the study: *First,* a horizontal black roof surface may reach a temperature as high as 170 F around noon on a clear July or August day due to the impingement of solar radiation on it. *Second,* this high temperature is maintained for only a comparatively short period of time at noon. *Third,* the rate of heat transfer through the structure never reaches the maximum which one would calculate from the maximum temperature difference between the top and bottom surfaces.

The greater the heat capacity of the structure the greater the difference between the maximum calculated rate of heat transfer and the measured rate. There is always a considerable lag between the maximum rate of heat penetration through to the top surface and through the bottom surface of the structure which lag increases with the increase in heat capacity of the structure. For a structure equivalent to 30 in. of concrete this lag amounts to approximately 15 hours so that the maximum rate of heat penetration into a building of this construction due to the maximum intensity of the sun around noon does not occur until early the next morning, while the minimum rate of penetration into such a building due to the cool of the preceding night takes place about the middle of the afternoon. The work

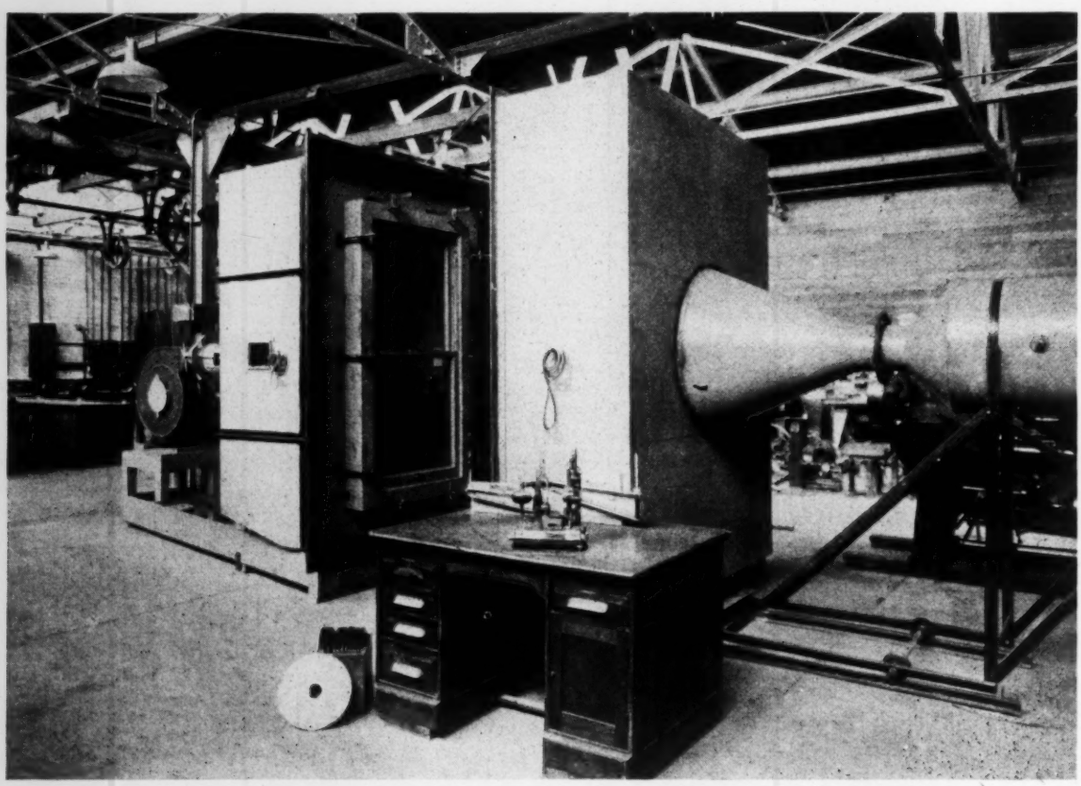


FIG. 5—STUDY OF INFILTRATION THROUGH BUILDING CONSTRUCTION BY PROFESSOR LARSON OF THE UNIVERSITY OF WISCONSIN AND HIS ASSOCIATES OF THE UNIVERSITY OF WISCONSIN IN CO-OPERATION WITH THE RESEARCH LABORATORY. TEST ON A DOUBLE HUNG WINDOW TO SHOW THE RELATION BETWEEN INFILTRATION AND CRACK CLEARANCE

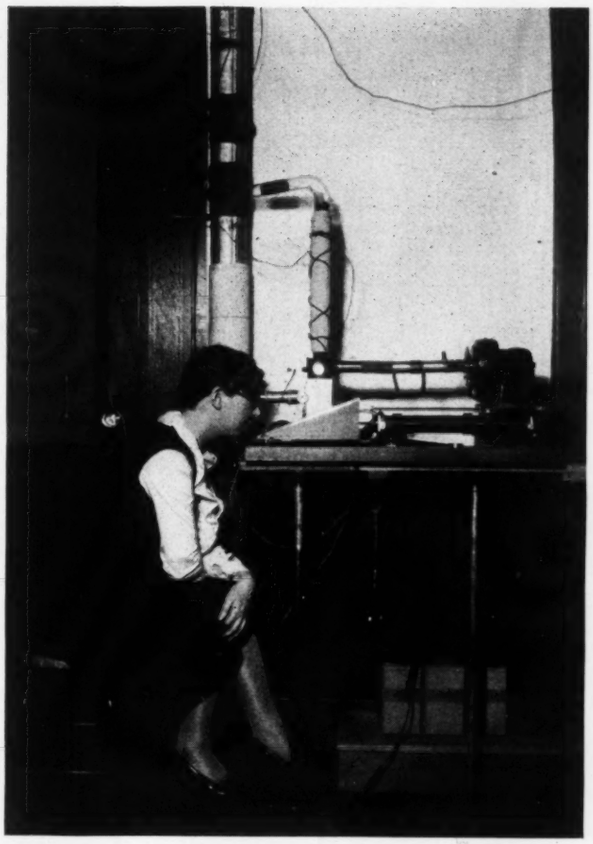


FIG. 6—STUDY OF THE IONIZED CONDITION OF THE ATMOSPHERE BY PROFESSOR YAGLOU OF HARVARD UNIVERSITY IN CO-OPERATION WITH THE RESEARCH LABORATORY. MISS BENJAMIN IS MAKING A DETERMINATION OF THE IONIZED CONDITION OF THE OUTDOOR ATMOSPHERE WHICH IS CIRCULATED THROUGH THE 5-IN. DUCT IN THE BACKGROUND. A SMALLER SAMPLE OF THIS CIRCULATED AIR IS DRAWN THROUGH THE INSTRUMENT WHILE THE OBSERVATION IS MADE

so far carried on permits of only a qualitative statement of these magnitudes. However, additional work which will be continued through the coming year will probably make it possible to calculate heat flow through any roof or wall structure due to the impingement of the sun on the outside for any time of day as accurately as the conductivity, specific heat and density of the material in the structure and the intensity of the sun can be evaluated.

5. Study of Methods of Evaluating the Efficiency of Air Cleaning Devices

Technical Advisory Committee

O. W. Armspach, *Chairman*
Albert Buenger
H. C. Murphy
Philip Drinker
C. A. Booth

Early this year Professor Rowley presented data on the effect of certain characteristics of design of an impinger type of dust counter on the consistency of results which might be obtained with different instruments and different observers. This study showed conclusively that the variation in operating the pump on this type of instrument by different observers resulted in a variation in impingement of the air jet upon the plate receiving the dust sample which in turn resulted in a variation in characteristics of the sample collected for count. It was also shown that other factors such as the location of the orifice with respect to its distance from the slide and the size of the orifice resulted in inconsistent determinations. With the completion of this phase of the study the project has remained dormant pending the development of instruments in which these variable factors will be eliminated.

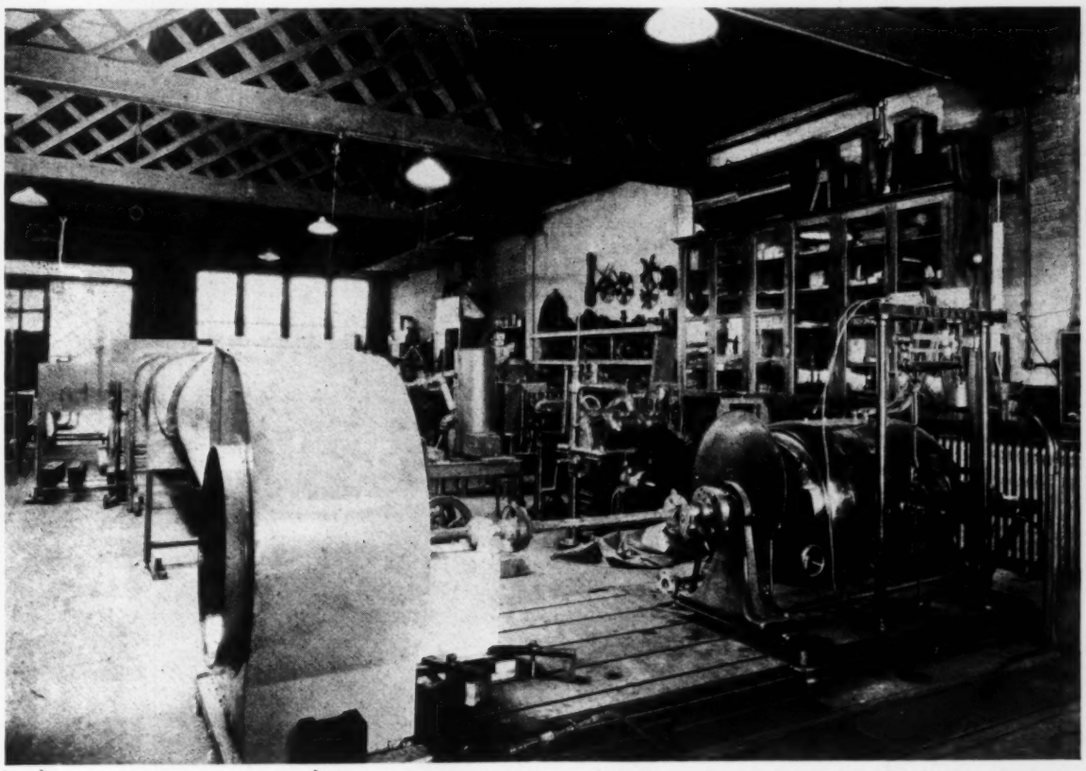


FIG. 7—LABORATORY OF ARMOUR INSTITUTE OF TECHNOLOGY WHERE A STUDY IS BEING MADE BY PROFESSOR DAVIES IN CO-OPERATION WITH THE RESEARCH LABORATORY OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS AND THE VENTILATING CONTRACTORS EMPLOYERS ASSOCIATION OF CHICAGO

The present activity in connection with this study is aimed towards the development of standard specifications for an impinger type of instrument for use in dust counts for testing air cleaning devices. With the proper instrument available the next step will be to write a code for testing air cleaning devices.

6. Radiation

Technical Advisory Committee

A. P. Kratz, *Chairman*
S. R. Lewis
R. S. Franklin
H. F. Hutzel
J. F. McIntire

At the 1930 annual meeting of the Society it was agreed that the Research Committee might engage in the testing of radiators or similar devices for associations. The *Heating and Piping Contractors National Association* immediately presented a request that the Laboratory give an estimate of the possible cost of testing a large number of cast-iron radiators.

This report was given consideration by the Research Committee and the Technical Advisory Committee on Radiation, and it was agreed that the Laboratory would make such tests for the *Heating and Piping Contractors National Association* and a plan for carrying out the work was developed including specifications for a test room which was to be built in Pittsburgh. The *Heating and Piping Contractors National Association* was advised that the Laboratory would undertake the work and would be ready to make the test within a month after it was certain that radiators would be provided. This study awaits further development.

7. Infiltration

Technical Advisory Committee

G. L. Larson, *Chairman*
J. G. Shodron
M. S. Wunderlich
C. C. Schrader
J. E. Emswiler
D. S. Boyden

During 1930 the Laboratory continued the study of air leakage through certain walls in the available apparatus in Pittsburgh and as a result published a paper entitled Air Leakage Through Various Forms of Building Construction which appeared in the December 1930 issue of the JOURNAL of the Society.

This paper, which was presented at the 1931 Annual Meeting, contains data on the following types of construction which will be of value in further improving the infiltration data in THE GUIDE:

1. A 13-in. brick wall without plaster.
2. The same wall after the application of plaster.
3. The same wall after the plaster had been removed and the joints repointed.
4. The same wall after the application of 1, 3, and 6 coats of paint to the brick.
5. A frame wall consisting of siding, paper, sheathing, stud, lath, and lime plaster.
6. A frame wall consisting of siding, paper, sheathing, stud, lath, and gypsum plaster.
7. The same as No. 6 with the application of sizing and paper to the plaster.
8. A frame stucco wall consisting of 7/8-in. sheathing, studding, paper, lath, and stucco.
9. A 13-in. brick and hollow tile wall.

The paper also contains data on air leakage through a crack between plaster and a door or window frame or baseboard.

During the first part of the year Professor Larson continued the study of air leakage through brick and frame walls at the University of Wisconsin in co-operation with the Laboratory. See Fig. 5. As a result of this study a paper entitled Air Infiltration through Various Types of Wood Frame Construction was published in the June 1930 issue of the JOURNAL of The Society and presented at the 1930 semi-annual meeting. This paper contained data on a large number of types of frame construction and will be of immense value in perfecting the infiltration section of THE GUIDE.

Professor Larson is now studying certain phases of air leakage around weather-stripped windows and the general subject of air drift across a building due to leakage in through the windows on the windward side, and leakage out through the windows, on the leeward side of the building.

8. Atmospheric Dust and Smoke

Technical Advisory Committee

A. S. Langsdorf, *Chairman*
E. V. Hill
H. C. Murphy
Dr. S. W. Wynne
O. W. Armspach

The study of atmospheric dust and smoke is a new venture with the Laboratory and was undertaken through a co-operative agreement between Washington University, St. Louis, and the Research Laboratory. According to this agreement, Dean Langsdorf is making a study of dust counting devices including a special scheme which he has for determining the dustiness of air by a light and electrical method. Dean Langsdorf is now undertaking this work but no results have yet been reported.

9. Air Conditions and Their Relation to Health

Technical Advisory Committee

W. H. Carrier, *Chairman*
A. C. Willard
Dr. E. V. Hill
W. A. Rowe
C. P. Yaglou

In this study which has been under way at the Laboratory for a number of years, work was continued on the determination of heat and moisture from the bodies of men working in still and moving air, and the heat loss from the bodies of children of school age. These phases of the study are now practically completed. A report of the heat and moisture loss from the bodies of men working was prepared and submitted to the *American Journal of Hygiene* and has since been approved for publication early in 1931.

The publication of Laboratory reports bearing on health and physiological subjects in physiological and public health journals was approved recently by the Research Committee, it being thought advisable to get this material into the hands of the medical profession before publishing it in an engineering journal. After the article appears in the medical journal an engineering paper will be presented to the Society.

Additional plans for the future in connection with this study include a recheck of the comfort lines and a study of the effect of radiation to cold walls on the feeling of warmth.

Mr. Yaglou and Professor Drinker of the Harvard School of Public Health in co-operation with the Research Laboratory have been working during the past two years on the relation between the ionized condition of the atmosphere and ventilating conditions in a building. See Fig. 6. A paper on this subject is promised for the near future.

10. Measurement of Air Flow Through Registers and Grilles

Technical Advisory Committee

S. R. Lewis, *Chairman*
John Aeberly
J. J. Haines
L. E. Davies
A. C. Willard

The study of methods of measuring air flow through registers and grilles is being carried on by Professor Davies of Armour Institute of Technology, Chicago, in co-operation with the Research Laboratory. See Fig. 7. The purpose of this study is to standardize methods of measuring air flow through registers and grilles. The problem was brought to the Laboratory by *The Ventilating Contractors Employers Association* of Chicago and the Chicago Chapter of the Society. Professor Davies undertook the work a little over a year ago and completed one phase of the problem resulting in the paper entitled Measurement of Flow of Air Through Registers and Grilles which was published in the January 1930 issue of the Journal.

Since making this report Professor Davies has continued the

study of other phases of the subject and will have another report ready early in 1931. Recently John Howatt, Chairman of a Council Committee which is developing a Code for Testing Unit Ventilators, called upon the Laboratory for data applicable to the measurement of air delivery from such units.

11. Study of Methods of Testing Oil Burner Devices

Technical Advisory Committee

L. E. Seeley, *Chairman*
H. F. Tapp
P. E. Fansler
H. R. Linn
J. H. McIlvaine
R. V. Frost

This study is being carried on by Professor Seeley of Yale University in co-operation with the Research Laboratory. The *American Oil Burner Association* is co-operating with the Research Laboratory in connection with this study and is contributing largely towards the cost of the investigation. The investigation has for its purpose the development of a standard code for testing oil burner, boiler, or furnace combinations. For the purpose of the study, several boilers and burners so arranged that the burners can be transferred from one boiler to another have been installed and tested under different conditions. As a result of this study a Code for Testing Steam Heating Boilers Burning Oil Fuel was developed which is presented to the Society for approval.

January 15, 1931.

After the presentation of the Report of the Director of Research, two of the laboratory papers were presented by title. These were Air Leakage through Various Forms of Building Construction, by F. C. Houghten, Carl Gutberlet and C. A. Herbert, (The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, December, p. 1044), and Capacity of Return Risers for Steam and Vapor Heating Systems, by F. C. Houghten and Carl Gutberlet. (The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, October, p. 687.)

Written discussions on the paper on Air Leakage were submitted by Margaret Ingels and D. W. Nelson. Miss Ingels warned that the air leakage through a given wall of a building may not be the product of the cubic feet of air per square foot times the area of the wall. She indicated that the infiltration of a wall is the sum of three factors (1) infiltration due to cracks of windows in the wall; (2) infiltration through walls and (3) infiltration due to space within the wall which permits air flow between portions of the wall.

Mr. Nelson stated that the paper in question shows the variations that may be expected from different constructions built under different circumstances by different mechanics, and discussed in detail the results reported. Among other things he stated that it is interesting to note that the test on one particular brick and tile wall at the end of 13 months indicated over 20 per cent more leakage than did the test at 3 months.

H. M. Hart submitted a discussion on the paper Capacity of Return Risers for Steam and Vapor Heating Systems, and stated that it not only gives much needed information on the proper sizing of pipes, but also brings to attention the importance of giving very careful consideration to the time allowed for filling the system with steam. There are undoubtedly cases where it might be a good investment for an owner to have a system that can be filled with steam in 20 minutes, Mr. Hart stated, but he was of the opinion that 40 minutes was adequate for the average installation. He emphasized that the time element has a very direct bearing on the size of pipes to be used, and should be considered.

The next paper was Welded Piping for Building Heating Systems, by F. G. Outcalt, which was presented by the author. (The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, October 1930, p. 855.) After the presentation of this paper by Mr. Outcalt, John Howatt stated, in a written discussion, that comparative costs between screwed and welded joint jobs for steam lines would be very interesting. Among other things he said that the paper points out that a factor of safety is provided by building up a welt of iron on the outside of the joint one-fourth the thickness of the pipe wall. Some welders, Mr. Howatt stated, finish the joint almost smooth, while others build up a heavy ridge around the pipe.

Written discussions by G. D. Luce, Jr., W. C. Bevington and W. H. McCaully, were read by P. D. Close, Technical Secretary of the Society.

H. M. Nobis, in discussing this paper, stated that his standard has been to eliminate welding on piping below an inch and a quarter. J. C. Fitts drew attention to the fact that the manufacturers and the engineers are looking to the *Heating and Piping Contractors National Association* to solve some of the welding problems and added that his organization has been working diligently on this subject for the last two years, and could promise to have the results of some of these studies ready by the middle of March. He further added that the ideal to which all are looking, is to have the welding torch become another tool of the steam fitter.

W. R. Rhoton discussed in some detail the necessity for securing reliable men for welding, and called attention to one job where a so-called expert welder made 22 welds, of which 17 were defective. L. A. Green made some interesting remarks in connection with the instruction that was being given the local steam fitters of Pittsburgh on welding.

P. F. Sullivan concurred with the remarks that had been made on welding, and touched on some of his experiences in Chicago in the training of steam fitters for welding work.

Mr. Bradley asked if any effort had been made to specify the welding wire for welding purposes, to which J. C. Fitts replied that his organization had not specified any wire by trade name.

In closing the discussion, Mr. Outcalt mentioned the co-operation that had been given by the Board of Education of the City of Chicago. He stated that the problem of certification of welders mentioned by Mr. Roton has been given considerable thought in the piping industry, as well as in many other industries, and he advised that it is the opinion of those who have studied the subject that the certification of welders will lead to questionable results. As to the 10 per cent saving mentioned in the written discussion by Mr. Bevington, Mr. Outcalt ventured the opinion that this amount could not be expected on every job, and that in fact in some cases there would be no saving, but that you would probably have a better job. Referring to the remarks by Mr. Nobis regarding the use of pipe an inch and a quarter or larger, Mr. Outcalt called attention to an article in

HEATING, PIPING AND AIR CONDITIONING in which reference was made to the possibility of obtaining very low frictional coefficients with well made joints. The speaker mentioned that copper bearing pipe can be welded satisfactorily.

The next paper on the program was Air Pollution from the Engineer's Standpoint, by H. B. Meller, which was presented by the author. (The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, January, 1931, p. 70.) Written discussions of this paper were submitted by H. H. Kimball, Col. E. H. Whitlock and Dr. C. B. Maits of the Department of Health of Pittsburgh. Dr. Maits read his discussion, and among other things stated that there is no question that air pollutants act as irritants to the eyes, nose, throat and lungs, and that some also enter the gastro-intestinal tract.

F. O. Anderegg presented a very interesting discussion which was illustrated by slides. He spoke particularly of the deleterious effects of sulphurous gases.

Percy Nicholls said that it was the function of the Society to have more papers on, and to pay more attention to that portion of the smoke production problems, which is outside of the province of the smoke abatement organizations.

E. C. Evans called attention to smoke bulletins issued by the Mellon Institute which contain analyses of atmospheric conditions. Mr. Meller replied that only two of these bulletins are available, and that these are of lesser importance.

W. H. Carrier spoke of the damage caused by burning coal with a large sulphur content which persists whether visible smoke is produced or not. He suggested the possibility of using desulphurized coke or burning gas.

C. H. Berry stated that a large power plant is being constructed in London with a complete gas-washing establishment for removing the sulphur from the flue gases, as well as the dust.

H. M. Nobis told of some of the smoke abatement work in Cleveland, and stressed the importance of the co-operation of the women's civic organizations.

Dr. Jennings related that as a botanist in the Pittsburgh district for about 25 years, he had noticed a very interesting development in relation to the effect of smoke or gases upon vegetation, and he stated that a few years ago the delicate ferns in the conservatory across from the Bureau of Mines building were killed during the first week in September due to the sulphur gases in the atmosphere. He pointed out that there are zones of no vegetation adjacent to some of the larger industrial plants, and that as you go away from these plants the amount of vegetation increases, and that farther away the vegetation becomes normal. He emphasized the damage done by carbon monoxide, particularly on vegetation.

E. A. Jones stated that it is possible to remove by modern air-cleaning devices, including scrubbers, all of the sulphur products in the gas but the carbon bisulphide, which unfortunately cannot be removed by any present commercial process.

President Harding called on Dean Holbrook of the University of Pittsburgh, who stated that the problem of smoke pollution was not entirely that of the engineer, and he ventured to say that unless the engineer can have the co-operation of the public, he cannot do effective work in smoke prevention.

In closing the discussion, Mr. Meller stated that if a city has a code which specifies not to exceed two per cent sulphur, and if it is economically possible to reduce the sulphur content to one per cent, the sulphur problem is cut in half.

President Harding next called on Prof. F. B. Rowley, Chairman of the Research Committee, to give a report on the activities of the Technical Advisory Committees. Professor Rowley called attention to the wide range of subjects discussed at the meeting, and stated that as heating engineers, it was necessary to get into the field of, and co-operate with, the scientists and the physicists and the chemists. He also stated this field includes co-operation of the various branches of the industry—the contractors, the journeymen, steam fitters, the architects, the educators. He stressed the fact that the paper on smoke abatement, and the discussion of air pollution indicate that our organization could not by itself hope to solve this problem, in other words, that it is a joint problem and takes into consideration many factors.

President Harding referred to a matter of importance, namely, a request from various quarters to the officers of the Society for a revision of Section I of the Code of Minimum Requirements for the Heating and Ventilation of Buildings, which section deals with the subject of ventilation. He pointed out that this section is covered satisfactorily so far as engineers are concerned, but that apparently it is not presented in a satisfactory manner for legislative bodies.

Mr. Harding stated that the opinion had been expressed that it should be the function of a special committee to revise this section in co-operation with the various organizations that might be interested. He revealed that a number of state legislatures are at the present time proposing a revision of their ventilating codes for public buildings, schools, etc., and asked for an expression of opinion on the subject, and possibly a motion.

W. H. Driscoll informed the audience that he had been appointed as a member of the committee to revise the Code of Minimum Requirements, and said that there is a mistaken opinion as to the adaptability of the Code of Minimum Requirements for legislative purposes, if used in toto. He did not feel that it was the function of the Code of Minimum Requirements Committee, nor did it have the proper personnel to handle the problem brought up by Mr. Harding. As to the legislative requirements of the code, Mr. Driscoll expressed the opinion that the committee must understand and have contact with problems of legislation both in the state and in the municipality, and suggested that the incoming President appoint a special committee with the idea of utilizing the information contained in the present Code of Minimum Requirements, and preparing it for purposes of legislation both for state and municipal codes. This suggestion he submitted in the form of a motion, which was seconded.

W. H. Carrier expressed the thought that the Code of Minimum Requirements as now written is an engineer's code, and is admirable as such, but thought that there should be more specific recommendations which would be usable to the layman and more understandable to him.

The motion submitted by Mr. Driscoll was carried.

J. Shodron, president of the Wisconsin Chapter, ex-

tended an invitation to the Society to hold the Summer Meeting, 1932, at Milwaukee, and E. C. Evans of the Southern California Chapter extended an invitation to the Society to hold the Summer Meeting of 1932 in Los Angeles. These invitations were referred to the Council for consideration.

Fifth Session—Thursday, January 29—9:30 A. M.

The paper Smoke and Dust Abatement by M. D. Engle, was presented at the opening of this session by the author. (The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, February, 1931, p. 146.) After the presentation in abstract of this paper by Mr. Engle, President Harding expressed his appreciation for Mr. Engle's efforts, and stated that this paper would be excellent for reference purposes for engineers interested in problems of this type.

H. B. Meller, in a written discussion, said that the paper served to emphasize the fact that there is available adequate engineering knowledge to solve the problem of air pollution so far as emanations from stacks are concerned. Mr. Meller stressed the need of attention to hand-fired boilers and furnaces with their intermittent, inefficient firing.

H. E. Bumgardner, in a written discussion, gave a description of the H. E. B. Smoke Chart, which he stated is entirely different from any other chart heretofore devised. A written discussion submitted by A. C. Stern, expressed the thought that Mr. Engle's proof that the finer sized particles are relatively not objectionable because of the large area over which they are spread, was not conclusive and pointed out that the relative number of such small particles is many times greater than the number of coarse particles. H. B. Reynolds, in a written discussion, expressed the opinion that it should not be assumed that there is no problem in the case of very fine fly ash simply because it travels a great distance before settling to the ground. He stated that it is true that the density of precipitation is much less than in the case of the larger particles, but the nuisance is extended over a large area. Sabin Crocker discussed educational work required, smoke prevention and the economic value thereof in a written discussion.

President Harding informed the audience that the scrubber-type washer will remove a sufficient amount of the dust from agricultural limestone plants and cement plants so that it will pass the usual municipal ordinance, and will stop the complaints from people who live near these plants. He pointed out that this type of washer is not expensive to install, but that the operating cost is an item of importance.

The next paper, Spectral Distribution of the Energy Radiated from Metallic Surfaces at High Temperatures, by G. R. Greenslade, was presented by the author. (The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, January, 1931, p. 50.) This paper contains information of scientific value on the subject of radiation for metallic surfaces. While the data are not directly applicable to the problems of the heating and ventilating engineer, they are of considerable value in connection with certain phases of heat emission by direct radiation.

After Dr. Greenslade's presentation of this paper, Professor Kratz presented a written discussion which had been prepared in collaboration with A. E. Hershey. In this discussion, the opinion was expressed that too much emphasis cannot be placed on the importance of knowing very definitely the exact chemical and physical nature of a radiating surface when selecting emissivity coefficients for radiant heat transfer calculations.

W. E. Forsythe, in a written discussion, submitted that the data in this paper would have been much more valuable for some purposes if the results had been expressed in absolute units, that is, if the energy flux had been given in watts per square centimeter for a definite wave length range.

Mr. Gregg inquired as to whether Dr. Greenslade had investigated the effect of angle of emission on intensity of radiation and he also called attention to some of the results of a German investigator, E. Schmidt.

F. B. Rowley thought it would have been useful if Dr. Greenslade had included some of the metals used so extensively at present, such as aluminum, copper and brass, and to give comparative coefficients.

Professor Willard stated that this paper is the finest example of pure research which in his experience has been presented before the Society.

President Harding said that engineers in general are pretty well convinced that it is necessary to look to the physicist to point the way in much of the fundamental research. He inquired of Dr. Greenslade as to the type of pump employed in these experiments, to which the author replied that he used three pumps on the apparatus, two with a high vacuum chamber placed in series. The highest vacuum pump was of the rotary type of molecular pump. These two pumps were used in conjunction with the third pump which operates between large differences of air pressure.

In answering some of the questions which had been brought up by the speakers, the author stated that the radiation from the surfaces was in all cases normal radiation. As to the change of the arbitrary standards of intensity over to absolute intensity, he stated that this could be done without the necessity of reconducting experiments. This, he stated, is accomplished merely by means of a small vacuum chamber with two windows, one toward the flat surface and one toward the flat body.

The paper Insulating Effect of Successive Air Spaces Bounded by Bright Metallic Surfaces was presented by the author, L. W. Schad, who, in his introduction, stated that heat in his field is generally troublesome, and that they usually like to get rid of it, particularly in the case of electric machines where it is desirous that the thermal resistance be decreased. On the other hand, he stated, in the case of refrigerators, it is desirous that the thermal resistance be increased. (The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, November, 1930, p. 957.)

In a written discussion by Professor Queer, he stated that it was interesting to note that the insulating effect of bright surfaces was pointed out by Dickinson and

VanDusen in 1915. In this connection, Percy Nicholls referred to the work of Peclet. He expressed the opinion that it is not advisable to attempt to separate convection and conduction as was done in this paper, the two being so interlocked as to be difficult of separation from each other. Mr. Nicholls submitted that the value of the paper in question was that at this time there are a number of institutions investigating the subject of air spaces.

J. D. Edwards pointed out that metal foil is becoming more extensively used for insulating purposes, this principle having originally gained headway in Germany, where aluminum foil has been used for the bright metallic surfaces. He said that if an emissivity value of 0.10 is assumed for aluminum foil and the values recalculated for case 3, the heat transfer through three one-half inch air spaces will be 21 Btu by conduction, 23 Btu by convection, and 5 Btu by radiation as compared with 23, 23 and 5 Btu for the case where the bright tin plate separators were used.

Prof. A. J. Wood of Pennsylvania State College, and a Past President of the *American Society of Refrigerating Engineers,* stated that if this paper has done nothing else, it has brought out a discussion that he believes will aid in the solution of the question of air spaces. In going into this subject, Professor Wood said that a clearcut division between radiation and everything else should be made first.

Mr. Penney ventured to say that there was an advantage in trying to separate convection and conduction, as contrasted to Mr. Nicholls' statement on this subject. The difference, Mr. Penney said, may be an academic one, but according to his understanding, air conduction is the heat that is transferred by the molecular motion of the gases, and convection is the heat transfer due to the air movement.

The final paper on the morning program was Wind Velocity Gradients Near a Surface and Their Effect on Film Conductance, by F. C. Houghten and Paul McDermott, which was presented by Mr. Houghten. (The complete paper is published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, March, 1931, p. 229.)

In discussing this paper, President Harding spoke about experiments conducted at the University of Illinois about 15 years ago, the results of which have been widely accepted. He stated that a few years ago it occurred to him to check the results of some of the original experiments, as there seems to be no correlation between the wind velocities reported by the Weather Bureau and the actual wind velocities over a building wall surface. So he persuaded the Committee on Research to include on the program an investigation of this subject, particularly the correlation between wind velocities as reported by the Weather Bureau and actual wind velocities over various surfaces.

Prof. A. C. Willard said that the subject covered by this paper was of importance not only in building construction, but also in the loss of heat from ducts of small sizes as in buildings, and also of very large sizes as in tunnels and possibly in mines and in subway work. This paper, he revealed, also has a connection with the field of aeronautics.

Sixth Session—Thursday, January 29—2:00 P. M.

The paper on Utilization of Hot Springs for Heating in Iceland, by Ben Gröndal, illustrated by slides, was presented in abstract by P. D. Close, technical secretary. (The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, February, 1931, p. 174.)

The next paper presented was Off-Peak System of Electric Heating for Buildings, by Elliott Harrington. (The complete paper was published in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, November, 1930, p. 963.) The author emphasized the fact that he had endeavored, in his paper, to put over one particular point, namely, that it is possible in certain localities where either the power rate is low, or load factor conditions are favorable, or climatic conditions are favorable, to heat the home or office building at a cost commensurate with the benefits derived.

In a written discussion, P. S. Lyon said, among other things, that if it is foreseen that relatively low electric rates are economically sound, heating engineers will realize that the only apparent disadvantage of off-peak electric heating has been removed, and that this system of heating should progress rapidly in the United States.

Selby Haar, in a written discussion, drew attention to the fact that the work of Mr. Harrington and others is marking out a definite field for thermal storage heating systems which are governed in some cases by the economic considerations, and others by the convenience, cleanliness and other special characteristics of this type of heating.

D. T. Waby, who also submitted a written discussion, related some of his experiences for three years in connection with the operation of an experimental electric heating plant in LaGrange, Ill.

A. R. Stevenson, Jr., also wrote a brief discussion of this paper, and called attention to L. L. Elden's paper presented at the Twenty-second Annual Convention of the New England Division of the *National Electric Light Association,* in October, 1930, entitled, Load Building at Night and Off-Peak Water Heating.

L. P. Hynes in a written comment on this paper stated that no one who is familiar with power conditions doubts the desirability of securing as uniform a load demand as possible, but ventured to say that there is considerable diversity of opinion as to the best method of accomplishing this very desirable result. He pointed out some important factors which were not referred to in Mr. Harrington's paper.

A verbal discussion was given by Prof. E. O. Eastwood, who spoke about the extensive use of electricity for heating purposes in the Northwest due to the hydroelectric developments in that section which made possible low rates for heating purposes, but which he stated had been withdrawn, with the result that, in his opinion, the use of electricity for heating purposes has ceased to increase. He mentioned particularly that if electricity increases in popularity for heating purposes, it will be done primarily on the basis of cost rather than on the basis of the other factors enumerated in the paper.

The concluding paper was that entitled Heating with Exhaust Steam, by Perry West. This paper was presented in Mr. West's absence by Technical Secretary P. D. Close.

President Harding in commenting on this subject warned against the use of weekly or monthly averages in analyzing problems of this nature, and stated that there was only one way to go into the subject and that was to take the daily load curves for a period of a year, and the process steam load curve, and to proceed on that basis. He said that many installations had not come up to expectations because of improper analyses.

F. C. McIntosh, Chairman of the Committee on Rules of Award for the F. Paul Anderson Award, announced the rules under which the first award is to be made in January, 1932. He explained that this award was founded by Thornton Lewis at the 36th Annual Meeting of the Society in Philadelphia, January, 1930. At his request, the Council appointed a committee to prepare regulations governing this award. One of the stipulations is that the conditions governing any particular award shall be announced one year in advance. The Council has voted to give the F. Paul Anderson Award in 1932 to a member of the Society for outstanding service to the art of heating and ventilating.

The next item of business was the presentation of resolutions which were prepared by a committee of which J. F. Hale was chairman. The following resolutions were adopted:

RESOLVED THAT it is the sense of this meeting that we express our appreciation to the Chamber of Commerce of the City of Pittsburgh for the cordial welcome extended our Society by its representative.

RESOLVED THAT the Secretary of our Association be requested to express to the hotel management our appreciation of the excellent accommodations and service rendered during our stay in Pittsburgh.

RESOLVED THAT the members here assembled express their appreciation to the Westinghouse Electric and Manufacturing Company for their very interesting and illuminating demonstration and the opportunity afforded the President and President Elect of our Society to broadcast our message over their KDKA net-work.

RESOLVED THAT we extend to the several manufacturers identified with our industry our sincere appreciation for the very delightful visitations, which they arranged for the entertainment of our members and guests.

RESOLVED THAT the members here assembled at the 37th Annual Meeting of the Society extend to the Pittsburgh Chapter and its Committee on Arrangements our congratulations on the very interesting and unique program provided for our entertainment.

RESOLVED THAT the Ladies' Committee of our 37th Annual Meeting be congratulated for the graceful manner in which they looked after the interests and comforts of their guests.

RESOLVED THAT the American Society of Heating and Ventilating Engineers here assembled wish to congratulate the Program Committee, the Authors, and the Technical Secretary of the Society for the excellent papers prepared and presented at this 37th Annual Meeting.

E. C. Evans called attention to the fact that Article IV of the Constitution specifies that the Council shall consist of twelve members. He pointed out that inasmuch as there are now sixteen Chapters, it is somewhat embarrassing to the Nominating Committee, and suggested that this reference be changed to read "one member from each of the chapter districts, and the total members of such to be elected each year, shall be equal to one-third of the number of such districts, so that each elected member shall serve three years." This would also necessitate a change in Article V.

After some discussion of this suggestion, it was agreed that it be referred to a committee which had already been appointed to revise the Constitution and the By-Laws of the Society, W. T. Jones being Chairman of this committee.

The final matter of business was the installation of the newly elected officers. With Past Presidents Willard, Driscoll, Hale, Hart and Anderson as escorts, W. H. Carrier, *President,* F. B. Rowley, *Vice-President,* W. T. Jones, *Second Vice-President,* and F. D. Mensing, *Treasurer,* were presented and retiring President Harding turned over the gavel to President Carrier. The new members of the Council, E. K. Campbell, Kansas City, R. Farnham, Buffalo, E. H. Gurney, Toronto, and E. O. Eastwood, Seattle, were introduced and installed.

After the presentation of the officers, President Carrier expressed appreciation for the honor that had been conferred upon him, and stated that the Society is growing in importance from year to year. He expressed the hope that it would continue to progress as it did under the administration of Mr. Harding.

In closing, Mr. Harding thanked the members of the Society and the officers who were associated with him during his administration for their wholehearted support.

Engineering Foundation Reviews Progress for 1930

H. Hobart Porter, chairman, and Alfred D. Flinn, director, of the Engineering Foundation, in presenting a review of the work for the year 1930, mentioned the following projects in some detail as either being suggested or upon which progress has already been made: Engineering Education; Wear Testing of Metals; Electrical Conductivity of Metals; Effects of High Temperatures on Metals; Clearing House for Engineering Societies Research; Arch Dam Investigation; Plastic Flow of Concrete; Alloys of Iron Research; Blast-Furnace Slags Research; Fundamental Properties of Dielectrics; Electric Welding Research; Wood-Painting Research; Personnel Research Federation.

Other researches, aided by the Engineering Foundation, but not reported in detail deal with Concrete Arches; Steel Columns; Earths and Foundations; Mining and Strata; Wire Rope, Strength of Gear Teeth, Wood Saws and Knives, Lubrication, Properties of Steam, Fluids for Cooling and Lubricating Tools Cutting Metals.

MEMBERS AND LADIES AT A. S. H. V. E. 37TH ANNUAL BANQUET, JANUARY 28, 1931

Entertainment Program at Pittsburgh Meeting

THOSE Pittsburgh people certainly know how to provide enjoyable entertainment, as the 37th Annual Meeting program was distinguished by some novel features of exceptional merit. R. B. Stanger was Chairman of the Entertainment Committee, and F. A. Gunther had charge of the banquet, so to them and their assistants a hearty vote of thanks is due.

On Monday, the annual luncheon for authors and council members was held in the Cardinal Room of the William Penn Hotel, and each of the authors was introduced. At 2:00 P. M. on that day, the ladies assembled at their headquarters in Peacock Alley of the hotel, and from there made a trip to Kaufmann's Department Store for an inspection and tea. This store, with its modernistic first floor with thousands of invisible bulbs, is often called the "floor of wonders." This event for the ladies was in charge of Mrs. H. Lee Moore.

A Night in Pirate Hall was the title given to a most delightful and interesting event held on Monday evening in Pirate Hall of the William Penn Hotel. An electrical demonstration was given by a Westinghouse representative in which the electric eye was featured. In this exhibition light rays were utilized to count people, sort products, extinguish fires and also control a miniature automobile by voice commands and without direct human control. After this demonstration, dancing to the tunes of Bobby Meeker's William Penn Hotel Orchestra took place. Facilities for cards were provided for those who did not care to dance. The festivities on this occasion were in charge of S. H. Harper.

A Ladies' Luncheon and Bridge Party was held in the Crystal Room of the William Penn Hotel at 1:00 P. M. Tuesday. Mrs. R. B. Stanger was hostess on this occasion, and the ladies were unanimous in their decision concerning the enjoyable time that was had by all. The ladies who demonstrated their superiority as players were Mrs. M. A. Benson, Mrs. L. C. Soule, Mrs. Murphy, Mrs. A. C. Willard, Mrs. S. H. Harper, Mrs. H. J. Church, Mrs. H. E. Jenkins and Miss Margaret Ingels.

The Country Club, a miniature golf course on the first shop floor of the William Penn Hotel, was the scene of activity Tuesday evening. The course was reserved for Society members for the entire evening. The Bobby Jones of the Society, so far as miniature golf is concerned, proved to be none other than Thomas Chester. F. A. Vance was in charge of this event.

The Past Presidents' Dinner was held on Tuesday evening, with twelve of the members of this exclusive club in attendance. Those who attended were H. M. Hart, John F. Hale, Homer Addams, J. R. McColl, R. P. Bolton, F. Paul Anderson, H. P. Gant, W. H. Driscoll, Thornton Lewis, S. E. Dibble and A. C. Willard. A dinner for the wives of past-presidents was held at the same time with Mrs. L. A. Harding as hostess.

At 10:30 A. M. Wednesday, the ladies assembled at the headquarters in Peacock Alley in the hotel and made an inspection trip to the Heinz plant, the largest of its kind in the world, and the home of the world famous 57 varieties. Following the visit to the Heinz plant, the ladies were taken on a sightseeing tour of Pittsburgh. Mrs. C. W. Wheeler guided the destinies of the guests on this occasion.

A luncheon for members and guests was held on Wednesday at the Pittsburgh Athletic Association. The facilities of the club were available to those who desired to use them and included the use of the swimming pool, billiard room, Turkish bath, bowling alleys, etc. Arrangements for this particular occasion were in charge of F. C. Houghten.

After the luncheon at the Pittsburgh Atheletic Association, a tour of inspection was made of the Research Laboratory and the Bureau of Mines, as well as Carnegie Institute of Technology. The itinerary in the U. S. Bureau of Mines Building included an inspection of the A. S. H. V. E. Psychrometric Room, the Mine Rescue Room, the Boiler Room where coking and gas making properties of coals are studied, the Fuels Laboratory, Garage No. 3 in which the A. S. H. V. E. Heat Capacity Study was described, the Metallurgical Laboratory, the A. S. H. V. E. Laboratory, the Coal Testing Room, the Health Laboratories and the Electrical Testing Room. The members and guests were escorted in groups of about twenty to the various places visited.

The Annual Banquet and Dance was held in the Urban Room of the William Penn Hotel at 7:30 P. M. Wednesday, January 28, 1931. W. H. Driscoll, Past President of the Society, acted as toastmaster, and performed his duties in a most efficient and entertaining manner. Cecil Farrar reported the results of the membership campaign, and pre-

sented the membership awards to Messrs. E. C. Evans, W. G. Hillen, Joseph Davis, Albert Buenger, Herman Nelson, S. E. Dibble and E. A. Kingsley. D. S. Boyden extended a formal invitation to the members and guests of the Society to attend the Summer Meeting of the Society at Swampscott, near Boston, June 23-26, 1931.

The presentation of the Past President's emblem to Mr. Harding was made by Prof. A. C. Willard of the University of Illinois. Professor Willard related various events in the life of Mr. Harding from the time the two met some 20 years ago up to the present time. These two outstanding members of the Society were associated together in many undertakings since their mutual acquaintanceship was first established. Professor Willard extended the highest praise to his distinguished colleague in presenting the highly-prized Past President's Medal.

The President's speech by Mr. Harding consisted of the presentation of a humorous paper entitled, Heat and Its Effect on Our Cultural Relationship with the Present Economic Situation. The paper was illustrated by slides, and the members and guests were kept in a continuous uproar by Mr. Harding's witty remarks. This incomparable presentation was particularly effective because of the way in which various well known members were placed on the grid.

Of the many interesting inspection trips arranged for members by T. M. Dugan, were visitations to Allegheny County Steam Heating Co., Pittsburgh; Armstrong Cork and Insulation Co., Beaver Falls; A. M. Byers Co., Ambridge; Columbia Radiator Co., McKeesport; National Tube Co., McKeesport; Oil City Boiler Works, Oil City; Westinghouse Electric and Manufacturing Co., East Pittsburgh. Arrangements were also made for the visitors to inspect the broadcasting station of KDKA located on the 21st floor of the William Penn Hotel. The KDKA Home Forum Test Kitchen is located on the 16th floor of the hotel, and the ladies were invited to visit the Model Test Kitchen.

Members from distant parts of the world attended the meeting, including one from Australia, one from France, one from Los Angeles, one from Seattle, and to quote President Harding, "one from McKeesport, Pa."

Mid-west Power Conference and Fuels Meeting

Three major events in the power-engineering field attracted more than 1000 engineers to Chicago for five days, beginning February 10. They were (1) the Fifth Midwest Power Engineering Conference, sponsored by the local sections, regional and professional divisions of the *A.S.C.E.*, the *A.I.M.E.*, the *A.I.E.E.*, the *A.S.M.E.*, the *A.S.R.E.*, the *N.E.L.A.*, the A.S.H.V.E., the *Western Society of Engineers*, and the *National Safety Council;* (2) the Fourth National Meeting of the A.S.M.E. Fuels Division; and (3) the Fifth Midwest Power Exposition. The conference and Fuels Meeting were held at the Stevens Hotel, and the Exposition at the Coliseum.

The Midwest Power Exposition seemed better in every way than the 1929 show as there was a more representative group of exhibitors with more interesting and novel exhibits. One noticeable feature was the number of small stokers on display.

The Power Engineering Conference opened on Tuesday noon, February 10, with a luncheon at which Maj. L. R. Lohr, manager, Chicago World's Fair, delivered an address on Power in a Century of Progress. H. W. Fuller, president of the Conference, presided.

The Conference was made up of six sessions. On Tuesday afternoon the session was devoted to Power Economics, with C. F. Hirshfeld as presiding officer.

Tuesday evening was devoted to two papers on refrigeration in air conditioning and central-station refrigeration. Alvin H. Baer presided.

The two sessions on Wednesday were devoted to prime movers, Alex D. Bailey, presiding, and to late developments in the electrical field, with R. F. Schuchardt in the chair. The papers of the morning session dealt with steam turbines, high-pressure steam engines, internal-combustion engines, and hydraulic turbines, and served as a résumé of recent development in these fields.

The sessions on Thursday were devoted to water-power problems of the power plant, with Prof. F. G. Straub presiding, and to civil engineering, with Major R. W. Putnam presiding.

While practically all papers of the Fuels Meeting followed the customary procedure of reporting upon engineering problems that had been solved or partially solved, and hence were matters of record, Geo. A. Orrok elected to look in the future in his paper, The Boiler Plant of the Future.

The final session, devoted to smoke abatement, was probably the most significant of the meeting. At it, smoke commissioners and other engineers interested in the subject and in the public welfare, called in no uncertain terms for prompt and effective attention to the problem by engineers, and left no doubt in the minds of those in attendance that the engineer has in the abatement of this offense against our civilization a very real obligation.

President Carrier to Visit Western Chapters

After holding a meeting of the Council in Chicago, Ill., on March 21, President W. H. Carrier and the Secretary of the Society, A. V. Hutchinson, will meet with the Kansas City Chapter members on March 23.

The next stop will be in Los Angeles, to attend the Southern California Chapter meeting March 31, where C. W. Farrar, chairman of the Committee on Increase of Membership, will join the party. Then meetings will follow at San Francisco April 2, Seattle, April 7, and Minneapolis, April 10.

Local Chapter Reports

Cleveland

December 16, 1930: The regular monthly meeting of the Cleveland Chapter of the Society was held in the rooms of the Cleveland Engineering Society with a number of the members of the Cleveland Association of Building Owners and Managers present.

By a unanimous vote H. M. Nobis was selected as the representative on the Nominating Committee to Attend the Annual Meeting in Pittsburgh, January 1931.

The speaker of the evening was F. I. Raymond, of the F. I. Raymond Co., Chicago, who spoke on the subject of Scientific Heat Control. Mr. Raymond illustrated his talk with lantern slides, explaining in detail the theory of the apparatus and its application. From Mr. Raymond's talk and from the interesting discussion that followed, the members and guests gained considerable knowledge. The apparatus which Mr. Raymond has devised, according to his description, is exceedingly unique and has considerable application for temperature control for buildings either large or small.

Illinois

February 9, 1931. The regular monthly meeting of the Illinois Chapter of the Society was held at the Hotel Sherman, Chicago, with an attendance of 58 members and guests.

Due to illness, President Carrier was unable to address the meeting as had been intended, so the principal attraction of the evening was the reading of the address made by Past-President Harding at the Annual Meeting in Pittsburgh. Through the courtesy of Mr. Harding, H. G. Thomas was able to secure a copy of this paper entitled, Heat and its Effect on our Cultural Relationships with the Present Economic Condition, which was accompanied by slides.

After the usual vote of thanks was extended to Mr. Harding, and an appropriate message was sent to Mr. Carrier for his speedy recovery, a very handsome electric clock was presented to William Howe, as a token of appreciation by the Chapter for his kindness in operating the lantern for a good many years.

The Better Relations Committee matter was reported on by Mr. Aeberly, who spoke of the progress made and the fact that H. M. Hart had been made chairman.

The proposition discussed during the Question Box period was, What is considered the minimum size of pipe economical to weld on the job? The question caused an interesting discussion which was followed by adjournment.

January 12, 1931: The Illinois Chapter of the Society held its January meeting at the Hotel Sherman, Chicago, with an attendance of 101 members and guests.

After the matter of transportation to the Annual Meeting in Pittsburgh had been discussed, A. G. Sutcliffe was appointed as Representative for the Illinois Chapter on the Nominating Committee, and E. P. Heckel was named as Alternate.

Dr. E. Vernon Hill, who was then introduced as the speaker of the evening, presented Aerology and Eternity; the physiological possibility of Air Conditioning, which proved to be a very interesting topic.

After a discussion on Dr. Hill's subject, the Question Box, a new feature of the Chapter, was introduced. The idea has been arranged so that any member may send in to the Secretary a question which he would like to have discussed at a meeting. The Secretary will refer this subject to several whom he thinks qualified to discuss it, and a brief amount of time will be given to the discussion at the close of the following meeting.

The question presented at this meeting was: What is the proper pipe to use for steam returns under a floor? A very interesting and instructive discussion took place, so much so that a suggestion will be made to the Council of the Society that this subject be given further consideration.

The meeting was adjourned with a vote of thanks to Dr. Hill.

Kansas City

December 8, 1930: Twenty-two members and guests of the Kansas City Chapter assembled at the Ambassador Hotel, where Pres. E. K. Campbell called the meeting to order.

Following the Treasurer's report, which was presented by Mr. Lewis, the President appointed N. W. Downes as Chapter Representative on the Nominating Committee, with J. M. Arthur as Alternate.

The members then rose in honor of the birthday of L. W. Millis, who has been a constructive force in Chapter and Society work for so many years. Messrs. Downes and Herrold were instructed to purchase a suitable Society emblem as a birthday gift to Mr. Millis from the Chapter.

E. H. Gill of the Industrial Division of the Kansas City Chamber of Commerce told of the steps that are being taken to provide employment for the citizens who are now out of work.

The principal speaker of the evening, Prof. J. V. Martenis, of the School of Mechanical Engineering of the University of Minnesota, brought news from his Chapter, and gave an interesting talk, illustrated with suitable slides, depicting the history of the development of heating and ventilating. His lecture was greatly appreciated by the members and guests present.

Massachusetts

January 20, 1931: The regular monthly meeting of the Massachusetts Chapter was held at the Chamber of Commerce Building in Boston, which was attended by 25 members and guests.

In the absence of President McCoy, David Moulton welcomed those present and after dinner introduced Alfred Kellogg, who presented a paper on the manufacture and use of pottery in trade. Mr. Kellogg traced the application of pottery to industry from before the Christian era down through the ages to present day methods of manufacture. The presentation was instructive as well as entertaining.

This was followed by two reels of motion picture film entitled, Carbon Monoxide, the Unseen Danger, and Saving Fuel in the Home, which were enjoyed by all.

Michigan

January 12, 1931: Eighty-one members and guests of the Michigan Chapter of the American Society of Heating and Ventilating Engineers attended the monthly meeting held at the Cadillac Athletic Club, Detroit.

During the dinner, William Whelan and R. K. Milward provided entertainment in the form of an orchestra and group singing. Popular songs were thrown on a screen and the entire assembly joined in the chorus.

The first speaker of the evening was Ray S. M. Wilde, Consulting Engineer of Detroit, who gave a description of the mechanical equipment used in the Cranbrook School for Boys, which is a preparatory school located in Bloomfield Hills, a suburb of Detroit, designed by Prof. Eliel Saarinen, with Mr. Wilde doing the engineering. This building is one of a group of five in which the engineering treatment has been unusual.

Mr. Wilde's talk not only covered the reasons for his particular design but touched upon the results which have been obtained, making his address doubly interesting.

Following Mr. Wilde's address, P. S. Russel, Resident Engineer of the Detroit Lubricator Co., addressed the audience on the subject of Oil and the Requirements Necessary for its Proper Combustion. Mr. Russel's address was highly enlightening, due to the fact that his company furnishes parts to the majority of the oil burner manufacturers in the United States. Consequently his experience has been such that he is undeniably an authority. One point which he covered and which excited considerable interest was that low stack temperatures of oil fired boilers did not necessarily mean a corresponding high overall efficiency of the boiler, but to the contrary, quite often indicated excess air. Another statement which he made, which was news to even so-called oil experts, was that the color of oil in combustion was always clear and any other color of the flame which may exist is simply due to the carbon which is given off in combustion.

Following Mr. Russel's address, A. G. Hann, field engineer of the Detroit Lubricator Co., then addressed the audience on Developments in Practice and Devices because of the Use of Oil as a Fuel. His address being largely that of a practical engineer, was of real interest to his listeners.

The meeting was then turned over to a discussion which was indulged in at least by one-fourth of the members and guests present, indicating that both speakers had delivered a message of great practical use.

The meeting was brought to a close by the showing of a motion picture, released by the Bureau of Mines, Pittsburgh, entitled, Carbon Monoxide, The Unseen Danger.

December 15, 1930. The December meeting was held at the Cadillac Athletic Club, Detroit, with 90 members and guests attending.

The principal speaker of the evening was E. R. Shaw, Michigan Representative of the U. S. Chamber of Commerce. Among the interesting statements which Mr. Shaw made was the fact that stockholders and bondholders increased thirty-fold from 1909 to 1929. This has a direct effect on business conditions today, inasmuch as a great percentage of these stockholders and bondholders flooded the market with them when the crash came in 1929.

Mr. Shaw predicted that it would be many years before business conditions would reach the 1929 average, but he did think that by the middle of 1931, business conditions in this country would equal the average of business from 1925 to 1929. He indicated that the U. S. Chamber of Commerce national survey shows definitely that unnecessary restraint in buying of necessities is largely responsible for the delay in getting business back to normal.

Following Mr. Shaw's address a discussion was participated in by Messrs. Rowe, Chester, Brown, Fuller and McConachie.

After the regular business meeting the annual Keno Party took place. This year's party was greatly enjoyed by the membership at large, and was particularly successful.

Minnesota

January 12, 1931: The January meeting was called to order by President Forfar, after the regular dinner at the Men's Building, University of Minnesota, with 68 members and guests present.

President Forfar appointed M. S. Wunderlich as representative from Minnesota Chapter on the Nominating Committee of the Society.

Mr. Bjerkin announced plans to have Pres. W. H. Carrier as guest of the Minnesota Chapter in April. Following this announcement Prof. J. V. Martenis told briefly of his recent visit to the Kansas City Chapter as guest speaker at their December meeting.

C. E. Lewis, Lewis Corp., was then introduced as the speaker of the evening. Mr. Lewis gave a most interesting talk on humidity control and human comfort. Among the points brought out were, human comfort is affected by temperature, humidity and air motion and combination of these three factors; Proper humidification in homes prevents waste in fuel; it provides greater comfort, longer life to draperies, rugs, furniture, and, most important of all, promotes human health. It is more necessary to add to the moisture content in buildings, providing humidification, at the lower outside temperatures. With higher outside temperatures, very little additional moisture is required.

In the discussion which followed, Mr. Welter asked regarding quantities of water required to provide proper humidification, and Mr. Lewis stated that with an outside temperature of "0" approximately 1 gal. per hour would have to be evaporated in an average home containing 20,000 cu. ft.

In reply to questions by Mr. Bjerkin, Mr. Lewis advised the amount of water evaporated and properly diffused in a home depended on location of humidifier and type; that is, whether diffusion was accomplished by gravity or fan type humidifier. This discussion also included the effects of intermittent heat of oil fired vapor systems on humidification effects and the most advantageous connections for the heating element.

At the conclusion of the meeting a one reel motion picture film entitled Carbon Monoxide, the Unseen Danger, prepared by the U. S. Bureau of Mines, was presented.

December 8, 1930: The regular monthly meeting of the Minnesota Chapter of the Society was held at the Men's Union Building, University of Minnesota.

A short business session was held after the regular dinner, which was followed by the reading of the minutes of the previous meeting, and a brief talk by Pres. D. M. Forfar, who introduced some of the new members and spoke of the splendid work by membership team captains A. J. Huch and Albert Buenger.

Following this, the speaker of the evening, H. R. Harris, gave an illustrated talk on electric motors and control as applied to use in the heating and ventilating industry.

Western New York

January 12, 1931: The Western New York Chapter of the American Society of Heating and Ventilating Engineers held their regular monthly meeting at the Hotel Buffalo, with an attendance of 78 members and guests.

The speaker of the evening was J. A. Curtin, of D'Youville College, Buffalo, who gave an illustrated talk on The Marvels of the Sky, particularly the moon. His talk and his slides, many of which were photographs that were taken by himself, proved to be most interesting.

The Society officers and Council and also the members of the Ontario Chapter had been invited to this meeting, and the following were among the guests: L. A. Harding, *President;* W. H. Carrier, *First Vice-President;* C. W. Farrar, *Treasurer;* A. V. Hutchinson, *Secretary;* and Roswell Farnham, one of the members on the Council.

All of these officers spoke briefly of the activities of the Society, as viewed from their respective positions.

The Chapter officers were elected for the ensuing year as follows:

President, Joseph Davis.
First Vice-President, M. C. Beman.
Second Vice-President, D. J. Mahoney.
Treasurer, W. F. Johnson.
Secretary, J. J. Landers.

The Western New York Chapter has been honored during the

past year in being well represented among the officers of the National Society, the President, Treasurer and a member of the Council, all being from this Chapter.

The regular meetings, other than the Inaugural Dinner Dance and the June Dinner Dance, have been held at the Hotel Buffalo on the second Monday evening of the month.

Each meeting consisted of a dinner at 6:30 p. m., at which the speaker was the guest, some entertainment, a brief business meeting, and the presentation of the topic of the evening, followed by a discussion of the topic.

A summary of the meetings during the year 1930 is as follows:

March 10, 1930, Louis J. Summerhays, Rochester, N. Y., presented a talk with lantern slides on The Design and Construction of Chimneys, with particular reference to radial brick stacks.

April 14, 1930, Prof. J. A. Curtin, of D'Youville College, Buffalo, spoke on The Sun, the Big Furnace of Little Earth. This talk was illustrated with colored lantern slides. Professor Curtin held the undivided attention of his audience for nearly an hour and a half, after which a lively discussion followed. There was insistent demand from the floor that Professor Curtin return at a later date, to which he graciously consented.

May 12, 1930, called Kentucky Night, was the annual meeting of the Chapter with the Senior Engineering Class of the University of Kentucky. Dean Anderson and his boys have visited industrial plants in Buffalo and other cities for several years.

Mayor Roesch sent G. F. Fisk, Commissioner of Public Works, to represent the City of Buffalo, and convey the City's official welcome to the students from Kentucky.

June 17, 1930, was the Mid-summer Dinner Dance at the Automobile Club, Clarence, N. Y. This was a most enjoyable affair, all entering into the congenial spirit of the occasion.

October 13, 1930, Miss Margaret Ingels, M. E. of Carrier-Lyle Corp., Newark, N. J., spoke on Doing Something About the Weather. This was a fascinating illustrated lecture presented by Miss Ingels.

November 10, 1930, meeting was attended by 100 members and guests, and was presided over by President Burke.

The speaker of the evening was Dr. James Aston, Director of Mining and Metallurgy at the Carnegie Institute of Technology, and Consulting Metallurgist for the A. M. Byers Co. Dr. Aston is the inventor of the Aston Process of Wrought Iron Manufacture, and his lecture covered that development.

With slides and motion pictures illustrating the various steps of the process, Dr. Aston held the attention of his audience. The description of the new Byers plant at Harmony Township, Pa., devoted entirely to the manufacture of wrought iron pipe by the Aston process, was comprehensive and interesting.

December 8, 1930, Pres. Fletcher Burke presided over the meeting which was attended by approximately 75 members and guests.

D. E. French, Philadelphia, President of the Industrial Unit Heater Association, gave a talk on the Standard Code for Testing and Rating Steam Unit Heaters. Presenting the topic without the aid of charts or pictures, Mr. French gave a clear explanation of the code and its background. A lively discussion followed, after which Pres. L. A. Harding and C. W. Farrar, spoke briefly on the membership drive.

The financial status of the Chapter is sound, according to Secretary Mahoney's report. During the year an indebtedness to the Engineering Society of Buffalo was wiped out. A new agreement between the Chapter and the Engineering Society of Buffalo was entered into, and the Chapter is an Affiliated Section of the Engineering Society. The present President of the Engineering Society of Buffalo, Roswell Farnham, is not only a member of the Chapter, but also a member of the Council of the Society.

The spirit prevailing in the Western New York Chapter is that of alertness, ambition, good will, loyalty and co-operation, founded and fostered by the retiring President, Fletcher H. Burke.

Philadelphia

January 8, 1931: The annual meeting of the Philadelphia Chapter of the Society was given in honor of John D. Cassell, upon the occasion of his retirement from active engineering and business pursuits. The meeting was held at the Rittenhouse Hotel, beginning with dinner at 7:00 p. m. A number of out-of-town guests were present to do honor to Mr. Cassell, among whom were J. I. Lyle, E. T. Murphy, and A. V. Hutchinson, all of New York.

Immediately upon completion of the dinner, President Black presented the list of nominations for Chapter Officers and Board of Governors as prepared by the Nominating Committee, and upon motion duly seconded and carried, the following were elected to serve during the year 1931:

President, E. N. Sanbern.
Vice-President, L. C. Davidson.
Secretary, W. P. Culbert.
Treasurer, M. F. Blankin.
Board of Governors, H. G. Black, A. J. Nesbitt and J. H. Hucker.

After presenting the new Officers to the members and guests present, Mr. Black turned the meeting over to Thornton Lewis, who acted as Toastmaster of the evening.

Mr. Lewis in turn called upon William Dick, former Secretary of the Philadelphia School Board and personal friend of Mr. Cassell for more than forty years; Edward Merchant, business manager of the School Board, who was also associated with Mr. Cassell for a like period of time; and Stanley Yocum, Assistant Superintendent of the School Board for many years under Mr. Cassell. All three gentlemen spoke in the highest terms of praise of Mr. Cassell, and recounted a number of interesting incidents in their long association with Mr. Cassell in his work.

Mr. Lewis next presented John J. Wilson and A. C. Edgar, both of whom are Charter Members of the American Society of Heating and Ventilating Engineers. Mr. Lewis then paid high tribute to Mr. Cassell, both as an engineer and a member of the Society. At the conclusion of his talk, Mr. Lewis presented Mr. Cassell with a very handsome desk set as a remembrance from his friends in the Philadelphia Chapter.

Mr. Cassell, in accepting the gift, expressed his thanks and appreciation for the honor done him, and promised that he would work even harder in the future for the advancement of the Society interests, than he has been able to in the past.

The members and guests were then entertained by a number of selections by the Male Quartet, and at the conclusion of the entertainment Mr. Lewis called upon E. T. Murphy, who had made the trip from New York especially for this occasion to honor Mr. Cassell.

Hon. J. Hampton Moore, former Mayor of Philadelphia, was then called upon. Mr. Moore paid high tribute to Mr. Cassell both as an administrator and a citizen of Philadelphia. At the conclusion of Mr. Moore's address the meeting adjourned, with all those present wishing Mr. Cassell many, many years of happiness and health.

Ontario

January 12, 1931. The Ontario Chapter of the American Society of Heating and Ventilating Engineers held a special meeting, at which 52 members and guests were present.

Arrangements had been made by Mr. Thomas to inspect Toronto's new skyscraper, the Bank of Commerce. Following the inspection of the mechanical equipment in this building, dinner was served at the King Edward Hotel, and later an informal meeting took place.

H. J. Church was elected as the Ontario representative

on the Nominating Committee for the Annual Meeting at Pittsburgh.

E. Holt Gurney spoke on the Annual Meeting in Pittsburgh and urged as many members as possible to attend.

Pittsburgh

January 12, 1931. At the January meeting of the Pittsburgh Chapter of the Society the members entertained the ladies at the William Penn Hotel, where 56 members and guests were welcomed by President Houghten.

After all the plans for the Annual Meeting had been discussed the party adjourned to the Country Club Miniature Golf Course in the Hotel, where a tournament was held.

This was followed by dancing in Pirate Hall, which was enjoyed by all those who took part.

December 1, 1930. The regular monthly meeting of the Chapter was held in the Assembly Room of the Fort Pitt Hotel, with W. W. Stevenson presiding over the 36 members and guests present.

Following the reading of the minutes of the previous meeting and the various reports, H. Lee Moore discussed the plans for the Annual Meeting in Pittsburgh.

F. A. Gunther then reported for the Nominating Committee, and the following members were elected for the ensuing year:

President, F. C. Houghten.
Vice-President, R. B. Stanger.
Secretary, J. L. Blackshaw.
Treasurer, H. B. Orr.
Board of Governors, W. W. Stevenson, H. Lee Moore and C. W. Wheeler.

F. C. Houghten then took the chair and introduced the speaker of the evening, Prof. F. B. Rowley, Director of the Experimental Engineering Laboratories of the University of Minnesota, who spoke on his chosen subject, Research and Insulation.

Professor Rowley gave his address in a very interesting manner, showing the benefits the Society is receiving from its program of research, and showing some of the results obtained at the University of Minnesota, where heat transmission research is being carried on. His talk was illustrated with very fine slides, after which he showed three entirely new reels of motion pictures on the logging industry and its connection with the manufacture of thermal insulation board.

In appreciation for Professor Rowley's fascinating address the members and guests extended a rising vote of thanks to him.

St. Louis

February 4, 1931. The St. Louis Chapter of the Society held its monthly meeting at the Roosevelt Hotel, with Pres. R. M. Rosebrough presiding. Twenty-six members and guests were present.

Following the reading of the minutes of the previous meeting, a report was presented by a special committee, consisting of G. A. Myers, *chairman,* E. R. Barnes and F. J. McMorran, on the proposed registration law for professional engineers in the state of Missouri. After considerable discussion, a motion was made by C. A. Pickett and seconded by R. J. Smith, and was unanimously carried, to adopt a resolution as opposed to the proposed law in its form.

The meeting was then turned over to L. Walter Moon, *chairman* of the Program Committee, who introduced R. J. Smith and C. A. Pickett, both of whom gave a very enlightening description and discussion covering concealed radiation. After the reading of the papers, a discussion was entered into by the entire gathering.

January 7, 1931. Twenty-five members and guests assembled at the Roosevelt Hotel for the regular monthly meeting of the St. Louis Chapter of the American Society of Heating and Ventilating Engineers, with Pres. R. M. Rosebrough the presiding officer.

After the regular order of business had been taken care of, L. Walter Moon, *chairman* of the Research Committee, advised that a Question Box would be inaugurated and that each member is requested to provide the Secretary of the Chapter with a question before each meeting, which in turn will be referred to one having special knowledge pertaining to the particular questions. The questions and answers are to be presented before the Chapter for discussion at the next meeting.

The St. Louis Chapter was honored by having two out-of-town guests, John F. Hale, of Chicago, who complimented the Chapter on its ability to finance the monthly meetings, dinner dances and outings in the manner in which they do, and also H. E. Sproull, from Cincinnati, who spoke briefly on the automobile industry.

President Rosebrough then appointed C. A. Pickett as representative and L. L. De Neille as alternate to represent the St. Louis Chapter on the Nominating Committee of the Society at the Annual Meeting in Pittsburgh.

As guest speaker of the evening, G. K. Hopkins, engineer for the *Heating and Piping Contractors St. Louis Association,* explained in detail the operation and working principal of Certified Heat, which was a very instructive address. The members then moved that a rising vote of thanks be tendered to Mr. Hopkins, and this was unanimously carried.

December 3, 1930. F. H. Gaylord of the Hoffman Specialty Co. and a member of the Chicago Chapter, presented two interesting moving pictures entitled The Heat Thief and Controlled Heat. Mr. Gaylord gave a very interesting talk in connection with these pictures.

The business meeting included the election of officers and the following members were unanimously elected:

President, R. M. Rosebrough.
First Vice President, J. M. Foster.
Second Vice President, C. A. Pickett.
Secretary, C. R. Davis.
Treasurer, A. L. Walters.
Board of Governors: E. A. White, George Myers, F. J. McMorran and L. Walter Moon.

E. A. White, the retiring president, expressed his appreciation for having had the opportunity of serving as president, and complimented the Entertainment Committee on the success of the four parties held during the year.

The attendance at this meeting included 25 members and guests.

Southern California

December 16, 1930. The Southern California Chapter of the American Society of Heating and Ventilating Engineers had an unusually interesting meeting in December at the University Club of Los Angeles.

David Hall, Manager, Engineering Department, Los Angeles Division, Westinghouse Electric and Manufacturing Co., was the guest speaker of the evening. Mr. Hall spoke on the ventilating and cooling of electrical machinery with particular reference to closed systems, using hydrogen. He used numerous slides to illustrate his talk, tracing the development and growth of electrical machinery, which was thoroughly enjoyed by the members and guests present.

The meeting was well attended by an enthusiastic and appreciative group.

November 18, 1930. Forty members and guests gathered at the Engineers Club in Los Angeles for the November meeting of the Southern California Chapter.

After the business matters had been attended to, Pres. O. W. Ott introduced H. P. Etter of the Air Reduction Sales Corp., as the guest speaker of the evening. Mr. Etter spoke on Pipe Welding and illustrated his talk with two reels of motion pictures, after which a general discussion of the subject took place, which was considered most interesting.

Death of Dwight H. Faulkner

After a long illness Dwight Hall Faulkner died on February 8, 1931, in his 37th year.

He was born in Ashtabula, Ohio, and after graduating from Manual Training High School in Brooklyn, N. Y., he attended Yale University, receiving his degree in mechanical engineering from Sheffield Scientific School in 1917. He received his Ph. B. from the College of the City of New York.

Mr. Faulkner was a member of the Yale Club, Yale Engineering Association, the *A. S. M. E.*, and the New York Chapter of the American Society of Heating and Ventilating Engineers.

During the war Mr. Faulkner served in the Aviation Corps of the Army, and upon his return from the service was employed by the Bethlehem Steel Corp. In 1920 he went with Yale & Towne, and since 1922 had been with the H. B. Smith Co.

Mr. Faulkner's main interest was in mechanical engineering and he specialized in heating work. During the past ten years he designed some special instruments for use with internal combustion engines and gas analysis, perfected a boiler cleaning compound and designed a water feeding device.

Mr. Faulkner joined the Society in 1926 and had always been a regular attendant at Society and Chapter meetings. His presence will be missed and the Officers and Council regret the loss of so active and promising a member and extend their sincere sympathy to the members of his family who survive.

Funeral services were held at the home of his parents in Brooklyn and interment was in Peekskill, N. Y.

Rufus Kauffman Dies

Word has just been received of the death of Rufus Kauffman, a prominent member of the Philadelphia Chapter of the Society, who died on Thursday, December 11, 1930.

Mr. Kauffman was born near Leesport, Pa., on September 18, 1864. He started his business career with the Pottstown Iron Works, where he became foreman of the pipe shop. After leaving Pottstown he spent two years with Charles E. Monday & Co., and twelve years with Cramp's Ship Yards, both in Philadelphia.

While at the Ship Yards he had charge, in the Contract Hull Department, of pipe fitting work on all ships built in the yard.

Twenty-five years ago he started in business for himself as a heating contractor and engineer and continued in that business until the time of his death.

He had been a member of the Philadelphia Chapter of the American Society of Heating and Ventilating Engineers since 1921, and was well liked among his fellow members.

The Officers and the Council of the Society extend their heartfelt sympathy to his widow and children who survive.

Survey Report on Simplification of Steel Heating Boilers Discussed by Simplification Committee of Industry

A preliminary report of a survey, recently conducted by the division of simplified practice of the Bureau of Standards, on capacity ratings for low pressure steel heating boilers, was reviewed at a meeting of the simplification committee of the *Steel Heating Boiler Institute,* held in Pittsburgh, Pa., on January 27, 1931.

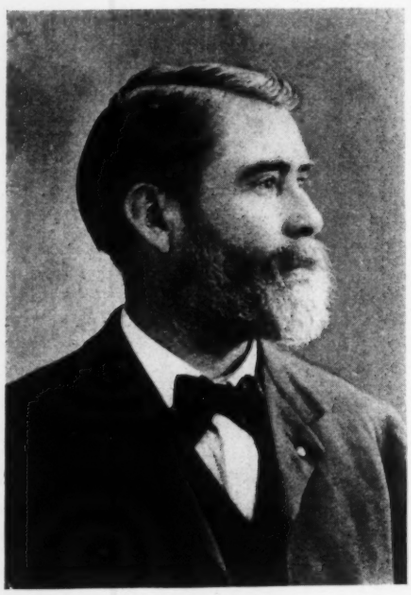
On the following day, the report was read before the annual meeting of the Institute, where it was decided that a proposed simplified schedule of ratings should be drafted by the simplification committee as a basis for a simplified practice recommendation in this field.

A complete summary of the results of this survey will be published as soon as all manufacturers have reported.

Death of Patrick Gormly

It is with profound sorrow that the Council and Officers of the Society announce the death of Patrick Gormly, one of the oldest members of the Society, which occurred on December 3, 1930, at his home in East Norristown Township, Montgomery County, Pa.

Mr. Gormly was born at West Chester, Pa., on January 5, 1847. In his early years he learned the trade of plumbing with William Fenner, and later joined the forces with Joseph Geisenberger under the name of Gormly & Geisenberger. This firm continued in business for about five years, purchasing during that time the Johnson Iron Works, manufacturers of cast iron pipe fittings. This partnership dissolved later, and Mr. Gormly started as a plumber under his own name.



Patrick Gormly

From this humble start grew one of the most successful piumbing and heating contracting businesses in the city of Philadelphia, from which he retired in 1910.

On his retirement from business Mr. Gormly purchased a small farm near Norristown, where he lived for the remainder of his life, with service to others always his guiding star. He served his community as Justice of the Peace and, during the World War, was engineer for the Savage Arms Co., using his knowledge in engineering power, heating and plumbing installations in many munition and aircraft factories.

A leader in his chosen line and a faithful member of his church, his memory will long survive him. Besides being a member of the American Society of Heating and Ventilating Engineers and of its Philadelphia Chapter, he was an honorary member of the *Master Plumbers' Association,* Past President of the *Heating and Piping Contractors' Association,* both national and local, and a prominent member of the Knights of Columbus.

The death of Patrick Gormly is not alone a great loss to the Society and his fellow members, but to the community in which he lived. The Officers and Council of the Society desire to express their sincere sympathy for the loss of their beloved member and useful citizen, Patrick Gormly.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the name of applicants and their references shall be printed in the next issue of the Journal of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Membership Committee as soon as possible.

When the Membership Committee has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 35 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Membership Committee, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some members by March 14, 1931, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
ARMSTRONG, ASHER D., Mgr., Heating Dept., Crane Co., Minneapolis, Minn.	Albert Buenger E. F. Jones	D. M. Forfar A. M. Wagner
ATKINS, THOMAS J., Standard Products Div., Carrier Engrg. Corp., Newark, N. J.	A. E. Stacey, Jr. E. T. Murphy	M. S. Smith Herman Worsham
BISCH, BERNARD J., Chief Engr., St. Mary of the Woods College, Indiana.	R. F. Prox D. L. Harmon *NON-MEMBER*	W. D. Wallace *NON-MEMBER* M. G. Flesher *NON-MEMBER*
BLACKMORE, JAMES S., Automatic Gas Steam Radiator Co., Pittsburgh, Pa.	G. C. Blackmore A. P. Weiss	C. J. Staud W. T. Van Alen
BOYD, SPENCER WALLACE, Head Draftsman, Robt. S. Newcomb, Cons. Engr., Atlanta, Ga.	C. L. Templin R. W. Alger	F. E. Baird E. W. Klein
CARR, MAURICE L., Staff Engr., Pittsburgh Testing Laboratory, Pittsburgh, Pa.	F. C. Houghten H. L. Moore	F. A. Gunther R. B. Stanger
CHAPPELL, HENRY DAVID, Sales Engr., B. F. Sturtevant Co., Detroit, Mich.	N. B. Hubbard L. L. McConachie	D. J. King R. S. M. Wilde
CONNER, RAYMOND M., Director, American Gas Assn. Laboratory, Cleveland, Ohio.	E. A. Jones W. E. Stark	J. G. Shodron H. L. Moore
ECKLEY, WILLIAM A., 3024 Irving Avenue S., Minneapolis, Minn.	Albert Buenger F. B. Rowley	A. B. Algren E. F. Jones
GOELZ, ARNOLD H., Vice-Pres., Brunswick-Kroeschell Co., Chicago, Ill.	E. P. Heckel Dr. E. V. Hill	Fred Lautenschlager J. D. Small
HARRISON, ARTHUR B. B., Multicell Radiator Corp., Lockport, N. Y.	Joseph Davis H. F. Hutzel	F. H. Burke L. N. Castin
HARRISON, CHARLES A., Secy., Treas., Multicell Radiator Corp., Lockport, N. Y.	Joseph Davis H. F. Hutzel	J. S. Snyder Roswell Farnham
HICKEY, DANIEL W., Healy Plbg. & Htg. Co., St. Paul, Minn.	E. F. Jones C. T. Gausman	Albert Buenger D. M. Forfar
JARRATT, PAUL R., Partner, Southern Sales Co., Nashville, Tenn.	J. W. Turner J. R. Collette	F. T. Tyler E. H. Beling
JOHN, VICTOR P., Dist. Mgr., American Blower Corp., Buffalo, N. Y.	Joseph Davis Wm. Roebuck, Jr.	J. J. Landers H. B. Roarke
JOHNSON, CLARENCE W., Manager, American Blower Co., Milwaukee, Wis.	J. H. Volk J. G. Shodron	W. H. Wilson C. H. Randolph
KRUEGER, BILL, Sales Engr., Bushnell-Felton, Inc., Buffalo, N. Y.	Joseph Davis H. S. Schall	L. R. Snelling E. J. Rogers *NON-MEMBER*
LANGLEY, FRANK P., Dist. Sales Mgr., The Trane Co., Snyder, N. Y. (*Advancement*)	Joseph Davis P. S. Hedley	L. A. Cundall C. A. Evans

LEWIS, JOHN P., Owner, Lewis Bros., Lebanon, N. H.	Phillips Eaton Coll T. Flint	Alfred Kellogg E. E. Tilden
MCTERNAN, FELIX J., Distributor, Minneapolis-Honeywell Reg. Co., Buffalo, N. Y.	Joseph Davis M. C. Beman	J. S. Snyder F. H. Burke
MILLER, ROBERT A., Tech. Sales Engr., Pittsburgh Plate Glass Co., Pittsburgh, Pa.	F. C. Houghten	H. S. Fox *NON-MEMBER* H. S. Heichert *NON-MEMBER*
NATHAN, JOHN M., Salesman, American Radiator Co., Buffalo, N. Y.	Joseph Davis W. F. Johnson	F. H. Burke F. S. Archer
NESS, WM. HENRY CLAY, Gen. Mgr. & Principal Owner, Master Fan Corp., Los Angeles, California.	J. B. Armitage E. C. Evans	H. B. Keeling A. G. Orear
NOWITZKY, HERMAN S., Wilmer & Vincent, Reading, Pa.	G. C. Lewis H. O. Koch	W. R. Murphy
PURCELL, HAROLD T., Partner, Southern Sales Co., Nashville, Tenn.	H. W. Nelson F. T. Tyler	E. H. Beling R. H. Nelson
RASMUSSEN, ROBERT P., Economy Equipment Co., Chicago, Ill.	R. E. Moore H. G. Thomas	C. W. DeLand
RENTE, HARRY W., Mgr., Oil Burner Dept., Buffalo, N. Y.	Joseph Davis F. H. Burke	W. F. Johnson H. S. Schall
RODMAN, MURTON J., Mf'rs Agent, 454 Ellicott Sq., Buffalo, N. Y.	Joseph Davis Wm. Roebuck, Jr.	H. B. Roarke J. J. Landers
RYAN, JOHN E., Branch Mgr., Pierce, Butler & Pierce Mfg. Corp., New York, N. Y.	E. T. McCormack M. A. Rooney	J. R. Murphy E. S. White
SCHULTE, ROSS R., Owner-Consulting Engr., R. R. Schulte, St. Paul, Minn.	Albert Buenger C. E. Hill	A. J. Huch H. J. Sperzel
SEELBACH, HERMAN, Pres., Equipment Sales, Inc., Buffalo, N. Y.	Joseph Davis F. H. Burke	W. F. Johnson H. S. Schall
SMITH, OWEN J., Salesman, Capitol Supply Co., Lincoln, Nebr.	F. H. Gaylord O. E. Davis	C. V. Haynes
STACY, STANLEY CONSIDER, Mech. Engr., Board of Education, Rochester, N. Y.	F. C. Houghten R. T. Coe	J. E. Emswiler J. M. Tracy
SWEET, HOMER K., Sales Supervisor, American Radiator Co., Buffalo, N. Y.	Joseph Davis W. F. Johnson	H. S. Schall L. R. Snelling
WATERMAN, JOHN HOWARD, Chas. T. Main, Inc., Boston, Mass.	J. W. H. Myrick D. S. Boyden	F. I. Cooper W. N. McKenna

Candidates Elected

In past issues of the Journal of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Membership Committee and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. II, Sec. VIII, of the By-Laws, the following list of candidates elected:

MEMBERS

CAMPBELL, WALTER E., Sales Engr., American Radiator Co., Los Angeles, Calif.

DOCK, CHESTER J., Uhl Co., Minneapolis, Minnesota.

HODEAUX, WALTER L., Owner, W. L. Hodeaux Plbg. & Htg. Co., Palm Beach, Fla.

LANOU, J. ERNEST, Part Owner, F. S. Lanou & Son, Burlington, Vt.

MILLER, EDGAR S., Branch Mgr., Pneumatic Process Corp., Kansas City, Kans.

OTT, RUSH C., Chief Engr., Peerless Unit Ventilation Co., Inc., Bridgeport, Conn.

POGALIES, LOUIS H., Wilbur Watson & Associates, Cleveland, Ohio.

PORTER, HERBERT M., Owner, Belden-Porter, Minneapolis, Minn.

ASSOCIATES

BREDESEN, BERNHARD P., Sales Repr., Herman Nelson Corp., Minneapolis, Minn.

HOYT, CHARLES W., Treas., Wolverine Heating & Ventilating Co., Inc., Boston, Mass.

JOHNS, CHARLES F., Heating & Designing Engr., Enterprise Foundry Co., Ltd., Sackville, New Brunswick, Canada.

MCINDOE, JAMES F., Branch Engr., American Radiator Co., Seattle, Wash.

REESE, PHILIP R., Manager, Minneapolis Branch, Herman Nelson Corp., Minneapolis, Minn.

SEEPE, RICHARD A., Sales Repr., Herman Nelson Corp., Minneapolis, Minn.

STEELE, HARRY G., President, U. S. Electrical Mfg. Co., Los Angeles, Calif.

JUNIORS

BRILL, JOSEPH W., Estimator, M. G. Lippincott, Hornell, N. Y.

DURNING, EDWARD H., Community Natural Gas Co., Dallas Tex.

FARNSWORTH, JOHN G., Central Illinois Light Co., Peoria, Ill.

GORBANDT, EVERETT T., Buffalo Forge Co., Buffalo, N. Y.

LUNDQUIST, RALPH A., Estimator, R. H. Baker Co., Cambridge, Mass.

Heating·Piping and Air Conditioning EDITORIALS

Piping *Is* Important

Just two years ago, when HEATING, PIPING AND AIR CONDITIONING was a well developed plan, but as yet had not published an issue, there were a few engineers who told us that "Piping" was not important enough to have a magazine, that there was nothing more to say about it, that the whole story was told in reference books and formulas. Of course, many other prospective (at that time) readers concurred with *our* opinion, that the piping engineer is almost in a profession by himself, that he needs a magazine to give him information on the new developments, the latest practical hints, and the important fundamentals of piping.

In looking over back files of HEATING, PIPING AND AIR CONDITIONING, it is interesting to note that in the neighborhood of five hundred pages have been published that relate directly to piping in its myriad phases. These articles range all the way from an article on shortening an almost-inaccessible pipe coil to a thorough review of the effect of higher pressures and temperatures on the design, the installation and the maintenance of piping; from piping a drinking water system to the X-ray inspection of pipe and fittings. Articles have been published on steam, water, air, oil, gas, refrigeration, hydraulic and process piping.

This magazine looks on every piping system as a *transportation system;* through correct design, installation and maintenance, important economies can be had. No industrial plant or other building can afford to neglect its piping systems, to consider them as just a part of its other mechanical services.

We are pleased to have comments from many of our readers who find that HEATING, PIPING AND AIR CONDITIONING is giving them the up-to-the-minute information they need on the many problems that the piping engineer encounters. Piping *is* important enough to deserve the careful editorial attention of a magazine—HEATING, PIPING AND AIR CONDITIONING has—and will—give it that attention and thus promote a greater appreciation of its growing importance.

The Home Atmosphere

One thing we had impressed on us at the recent Midwest Power Show is the ever-increasing interest in air conditioning for homes. Many visitors, noticing the title of this magazine above its booth, stopped to inquire about its various phases and numerous advantages.

Like air conditioning for almost every other type of building, air conditioning for homes is attracting greater and greater interest every day from the public. Soon some degree of air conditioning will be a necessity. As we've said before, some people will not want a complete system for the entire home; but at least they will require an air conditioned living room or dining room or partially conditioned air for the entire building.

Offices Need Air Conditioning

Reports come from the tenant of an air conditioned office building in Cincinnati that the control of atmospheric conditions has eliminated the usual lowering of efficiency of his employes in summer. "Because of the comfortable conditions last summer, our personnel turned out more work. They came earlier and stayed later, because the office was more comfortable than in unconditioned buildings," he says. "It is comforting to know that we will enjoy the same invigorating atmosphere all through the year as we have right now."

As described last month in HEATING, PIPING AND AIR CONDITIONING, air conditioning the Banks-Huntley office building in Los Angeles simplified the rental problem considerably. At the same time, tenants were willing to pay rents in proportion to the extra service the building offered. Not only were renters willing to pay the additional—though comparatively small—price for air conditioning, but they were eager to do so.

Air conditioning systems in numerous other offices are proving daily that the control of the atmosphere means profit for both the building owner and his tenant; it reduces vacancies, cuts cleaning costs, is paid for willingly through higher rentals, to mention but a few advantages. For the tenant, it increases the productivity of his organization, reduces labor-turnover, lessens expensive mistakes made by tired, uncomfortable minds. Street noise is kept out, as windows may remain closed.

Summer, with its hot, moist, enervating weather is but a few weeks away. Many firms, unfortunate enough to be located in old buildings that are not supplied with conditioned air, will find the solution in the purchase of unit air conditioning equipment, of which there are many reliable types. Many older buildings lend themselves to the installation of air conditioning for the entire structure. Most of our waking hours are spent in offices; by all means, these buildings should be air conditioned.

PRACTICAL PIPING PROBLEMS

Some Faults Found in the Inside of the Pipe Lines in a Large Industrial Plant

by **W. H. WILSON**

The Inside of the Pipe Line

Pipe work, in many cases, is judged by its outward appearance. This is only natural, as neatly assembled pipe lines with hangers and supports properly spaced and evenly adjusted, together with other details of good workmanship, will be certain to attract attention that will lead to favorable comment.

Inside Condition Important

The *inside* of the pipe line is frequently lacking in some of the points that it needs to conform to good workmanship. One of these is the matter of reaming the ends of the pipe in order to provide for unobstructed flow. Every one will agree that the ends of the pipe (when used for regular pipe work, outside of railings and supports) should be carefully reamed. Reaming the pipe or seeing that it is reamed is one of the hard problems that confronts the supervisor of a piping installation.

There are other things that affect the inside of the pipe line and the accompanying illustrations show some examples of actual occurrences.

Nipple Worn by Water

The upper drawing shows a steam line that was "dipped" in order to pass under a concrete duct. The size of this line was 1½ in. A normal steam pressure of 90 pounds per square inch, saturated steam, was maintained on this line at all times, except when special testing conditions required the pressure to be raised to 180 pounds.

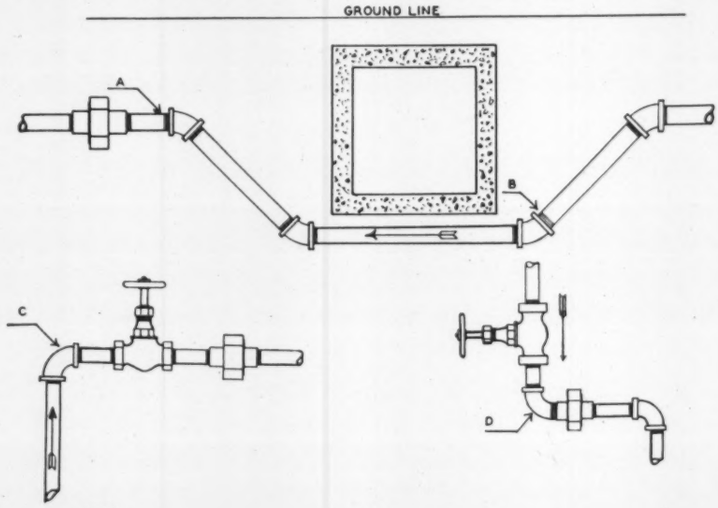
No steam trap was provided for draining the part of the line that was lowered to pass under the duct. The condensation in this part of the line was carried with the flow of the steam to a trap at the end of the line. The line was installed in a tunnel and fairly well insulated.

After a few years service a leak developed in the pipe nipple, as shown at *A* on the drawing. This nipple was of extra strong wrought pipe and when removed the interior was worn through on one end as shown at *A*, on the photograph. This apparently was due to the water in the steam carried by the flow at a high velocity and impinging on the end of the nipple. The pipe nipple was renewed and while this work was being done, the pipe line naturally contracted and was connected by pulling it together and tightening the union. This caused some strain to be put on the piping and a short time later a leak developed in the thread at the point *B*. This was apparently caused by a slight strain remaining on the pipe joints.

C on the drawing and photograph shows an elbow that was removed from a ¾-in. steam line. This was a long pipe line carrying 90 pounds steam pressure at the beginning of the line and the pressure at the elbow, due to the length of the line and numerous elbows and valves intervening, was from 20 to 30 pounds. The elbow was worn through as shown. The steam line was in use during the heating season.

The street elbow, shown at *D* in the photograph, was removed from a steam line, carrying 100 pounds pressure. It is worn through at one particular spot. This defect was not due, in this case, to the velocity and flow of the steam, as the line was seldom used. The street elbow was installed as shown at *D* in the drawing, being in a downward position. Apparently the valve had been leaking slightly and the drops of water from the condensation in the line, striking the interior of the elbow, caused a chemical action that wore through the elbow, causing it to leak.

Referring to *E* on the photograph, a ¾-in. pipe nipple

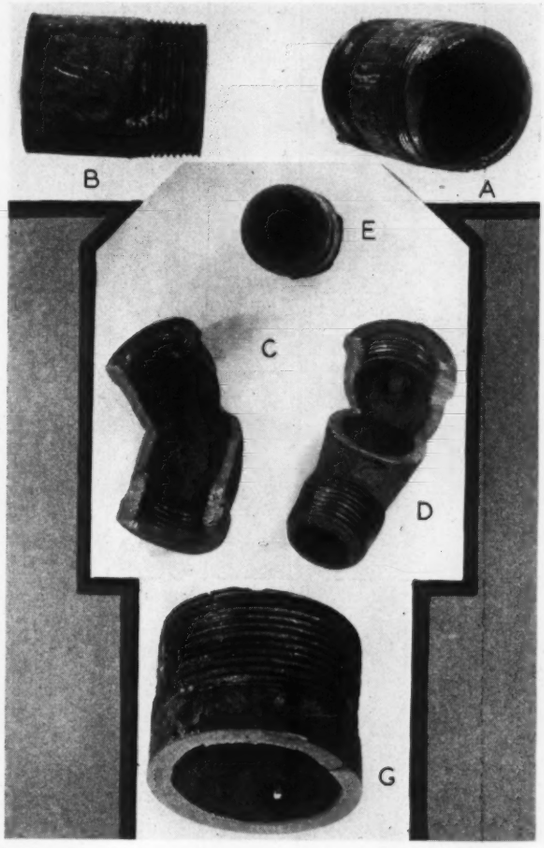


THE UPPER PART OF THIS DRAWING INDICATES HOW THE NIPPLE *A* AND THE PIECE OF PIPE *B* WERE INSTALLED. CLOSE-UPS OF *A* AND *B* AFTER REMOVAL ARE SHOWN ON THE NEXT PAGE

THE LOWER LEFT PART OF THE DRAWING SHOWS HOW THE ELBOW *C* WAS INSTALLED. LOWER RIGHT SHOWS THE METHOD OF INSTALLATION OF ELBOW *D*. CLOSE-UPS AFTER REMOVAL FROM THE LINE ARE SHOWN IN THE PHOTOGRAPH ON THE NEXT PAGE

is shown that was removed from a pump discharge line, the water being at atmospheric temperature. The nipple is worn away completely on one side of the threaded portion. The water contained no acids that would be detrimental to the piping.

G is a piece of 2½-in. wrought pipe that was removed from a boiler feed water line. This pipe is worn



A Shows a Nipple Which Was Installed as Shown in the Drawing on the Preceding Page. The Interior Is Worn.

B Shows a Pipe Thread Which Was Cut on the Outside by Leaking Steam.

C Shows an Elbow Removed From the Steam Line Shown in the Drawing at *C*.

D Shows a Street Elbow Removed From the Steam Line Shown in the Drawing at *D*.

E Shows a ¾-in. Pipe Nipple Removed From a Pump Discharge Line With Water at Atmospheric Temperature.

G Shows a Piece of 2½-in. Pipe Removed From a Boiler Feedwater Line.

through in one particular spot only, the remainder of the pipe being in good condition.

From these examples, it is clear that water in the steam is a contributing cause to the deterioration of the pipes and fittings, especially when steam travels through the pipe line at a high velocity.

Steam lines should be well insulated and provided with suitable traps and drains to remove the condensation.

The use of pipe bends, when the flow is strong, is an advantage, or fittings of the long radius pattern, instead of the regular fittings, will often aid materially in these cases.

Pipe work should be installed so as to be free from a strain on the joints. A joint that is subject to a continuous strain may hold tight for a time, but sooner or later will give trouble. Provision should be made to take care of expansion caused by temperature changes and proper hangers and supports should be used to relieve the joints of the weight of the pipe, fittings and other accessories.

Brass or bronze pipe is used in many cases for water lines, including boiler feed lines, on account of the corrosive action of water on the interior surface of some grades of steel and iron pipe. The manufacturers of wrought pipe have different kinds of pipe made from alloy steel that resist corrosion and will give good results.

When trouble is experienced in pipe lines, in the way of reduced capacity, a few pressure gages inserted in the line at different points will sometimes reveal things that can be corrected. There may be obstructions in the line, such as scale or foreign matter, quite often near reducing fittings. A collection of short elbows may be simplified by a rearrangement of the piping and the flow through the line increased.

The inside of the pipe line deserves its share of attention.

Phenolphthalein as an Indicator

Question: Phenolphthalein is often mentioned as an indicator for use with brine solutions. Explain how it is used in this way.

Answer: Phenolphthalein is a common indicator and a valuable one for use in this particular problem. It is colorless in neutral or acid solutions but becomes pink soon after the alkaline point is reached and is pink at about *pH* 8.5, which is a satisfactory *pH* value for a calcium chloride brine solution, being distinctly alkaline.

To make the examination, secure a small amount of brine, add a few drops of phenolphthalein solution (1 gram in 100 cubic centimeters of alcohol) and shake to mix thoroughly. If the test solution does not show a faint pink coloration it will be necessary to add caustic soda (sodium hydroxide) or milk of brine to the brine in the tank until the proper color reaction is obtained. Add the alkali to the brine in small amounts and permit time for thorough mixing before making the next test. The phenolphthalein solution mentioned above may be prepared by any prescription clerk and a few ounces of this solution should be adequate for a long period. Test the brine every few weeks to be sure that it remains alkaline.

With sodium brine, where disodium phosphate is used to reduce corrosion, the brine is maintained at as near the neutral point as possible. In this case the phenolphthalein should show a very faint trace of pink or should be colorless. It must be remembered, however, that once the indicator has lost its color further additions of acids, although they will increase the acidity of the solution, will cause no color change in the indicator, as it will continue to be colorless no matter how acid the solution is made. If acid is added to the brine until the pink color just disappears the proper condition will be indicated. If the solution is made too acid it may be brought back to the neutral point by additions of an alkali such as sodium hydroxide.